MECHANICAL ENGINEERING

· MARCH 1948 ·

Departments

MECHANICAL ENGINEERING, March, 1948, Vol. 70, No. 3. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75¢ a copy, $7.00 a year; to members and affiliates, 50¢ a copy, $4.00 a year. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

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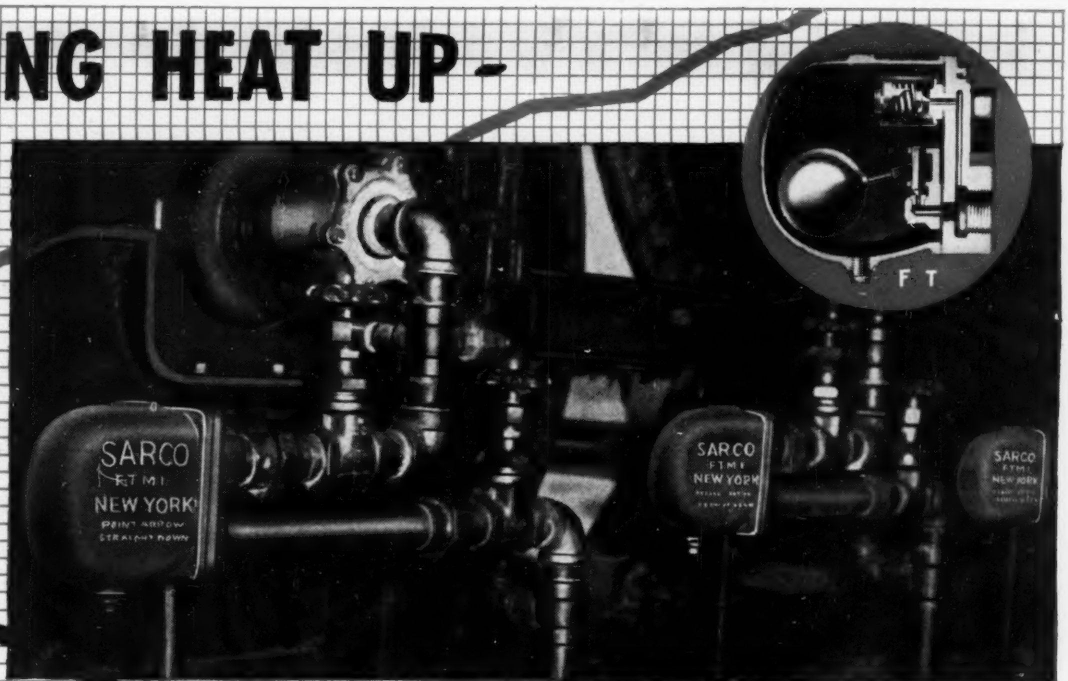
KEEPING HEAT UP—



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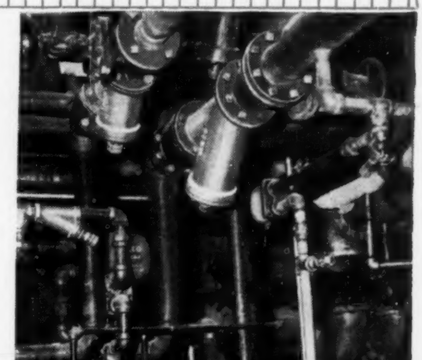

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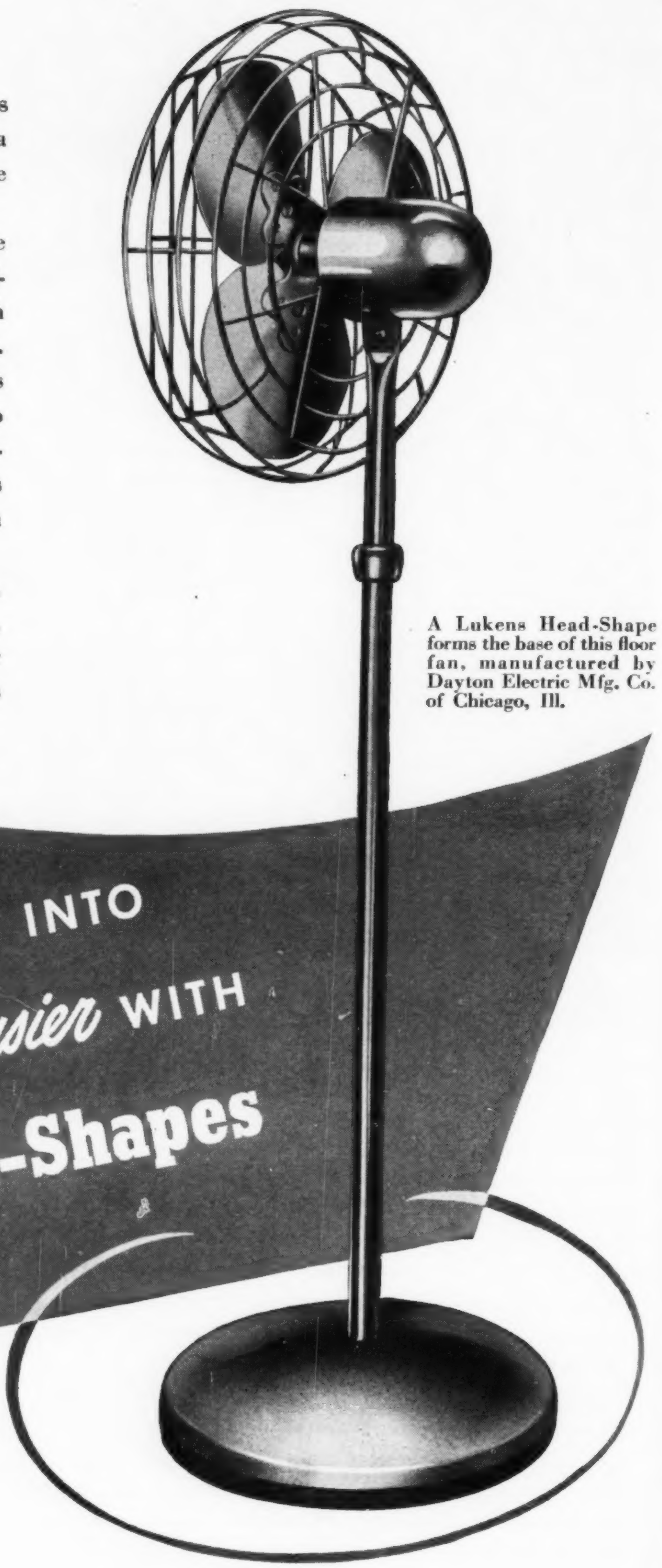

A Lukens Head-Shape forms the base of this floor fan, manufactured by Dayton Electric Mfg. Co. of Chicago, Ill.

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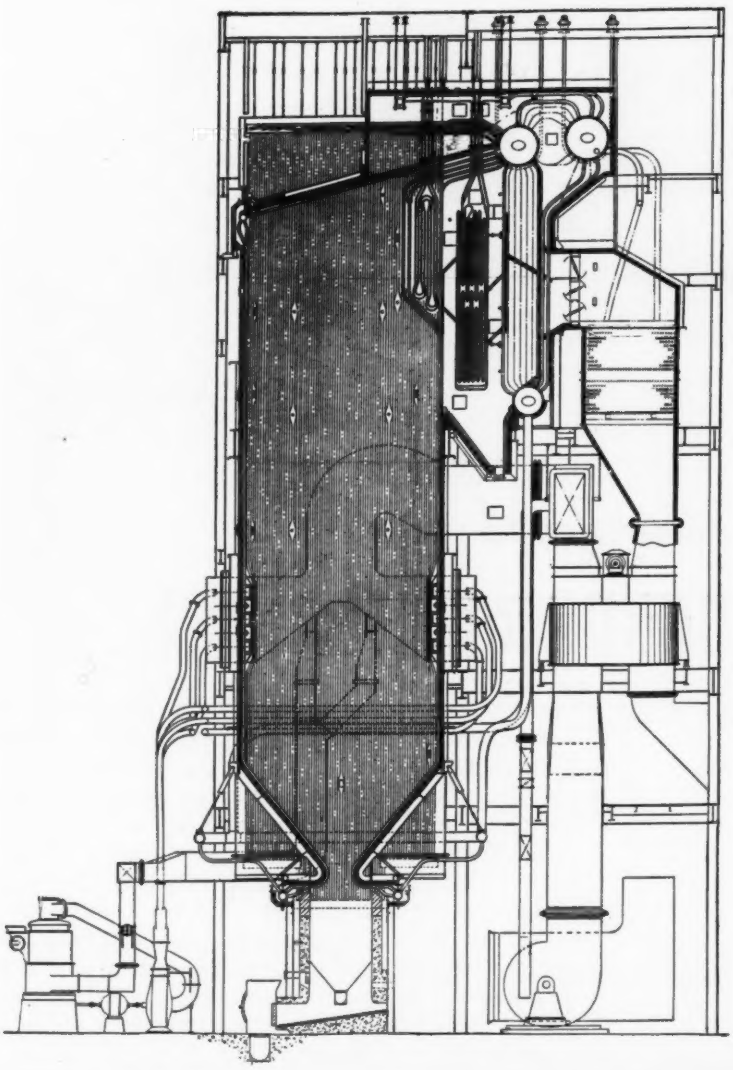

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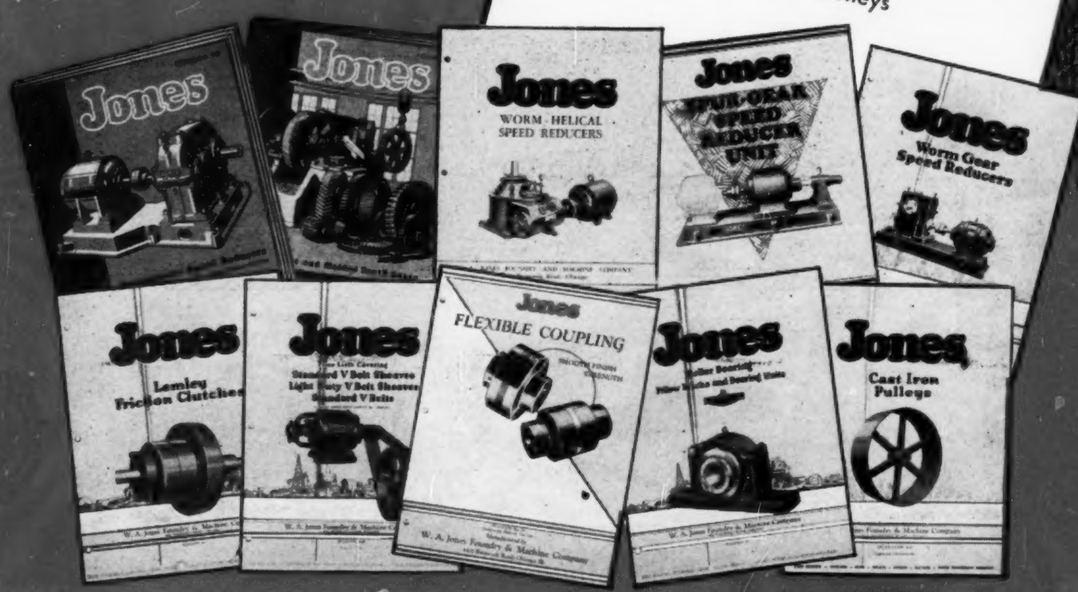

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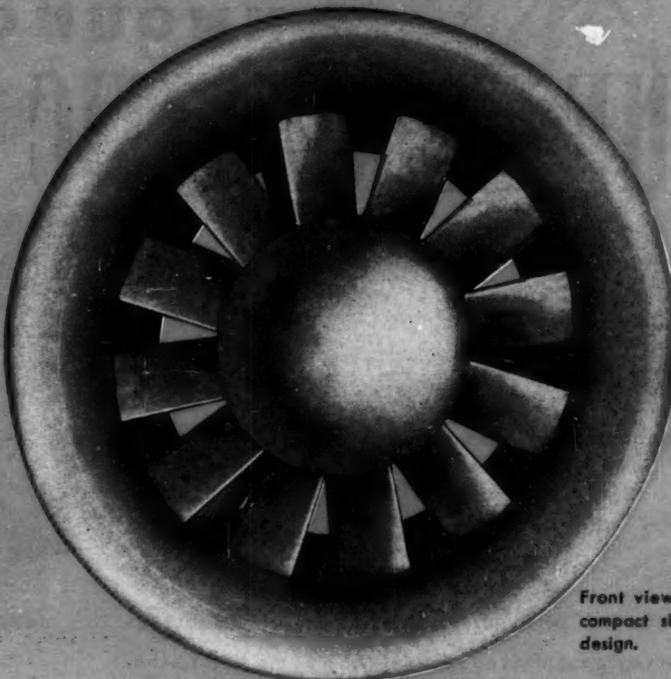

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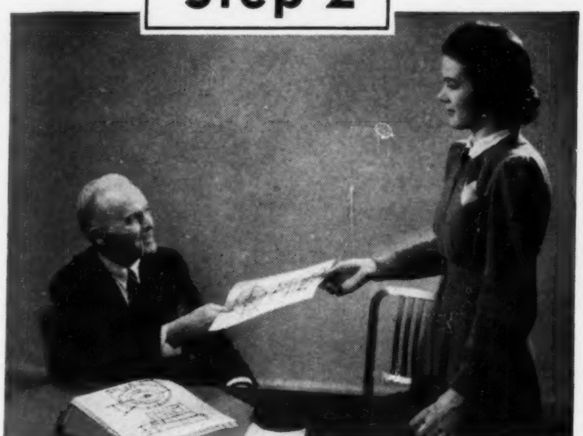
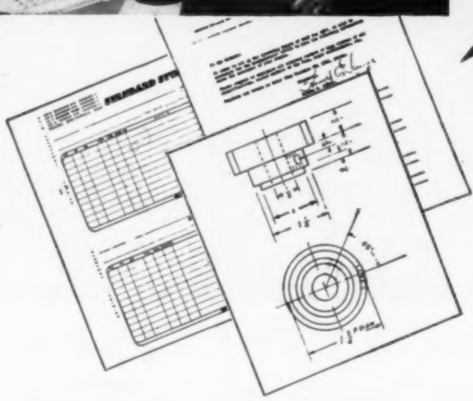
Step 2





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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 70 NUMBER 3

Contents for March, 1948

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the head quarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $7.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . .

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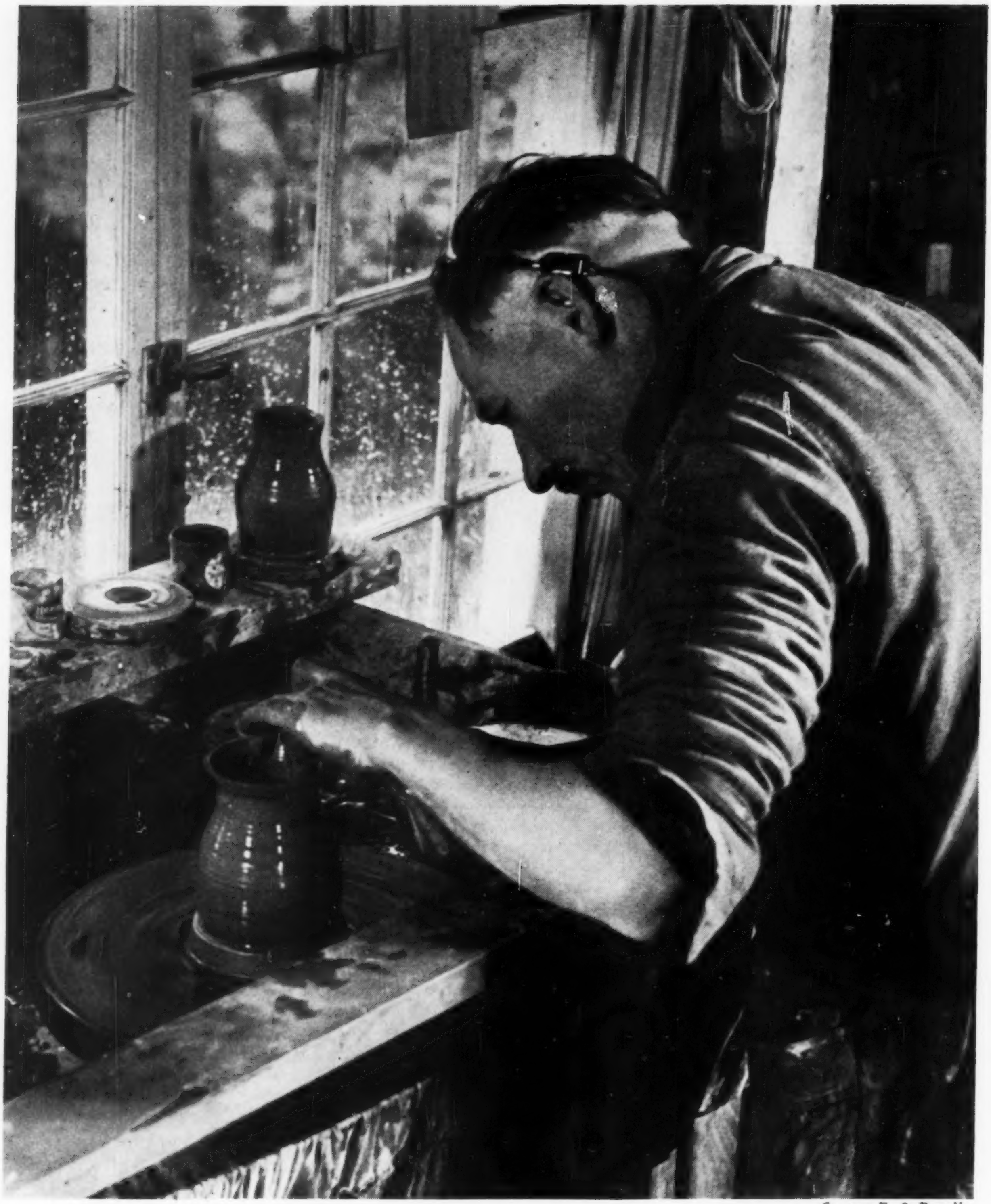

Courtesy E. S. Rowell

The Master's Touch

(Mr. Rowell also provided the photograph which was used as the cover of our February, 1948, issue.)

VOLUME 70
No. 3

MECHANICAL ENGINEERING

MARCH
1948

GEORGE A. STETSON, *Editor*

Junior or Associate?

THE membership of The American Society of Mechanical Engineers is made up of three groups of approximately equal size, each representing a different stage of professional maturity. They are the Student Members, the Junior Members, and the members of all other classes. That the Society is so rich in its resources that the young men outnumber men of maturity at least two to one is a fortunate circumstance, because from this great reservoir of human energy, intelligence, and enthusiasm will come the leaders and the workers in the ranks in whom future developments in the profession, in industry, and in the nation will originate and by whom they will be carried forward.

These two great bodies of younger men have much to contribute. The men who are now in school preparing for engineering careers are being subjected to an educational program that is richer and broader than any heretofore offered. The experiences of generations of progress in engineering education are bearing fruit in the curricula that our schools are offering. The environment of the college was never before so fully charged with seriousness of purpose and a desire for accomplishment. The environment of the industrial world was never before so cordial to engineering graduates, nor has the world ever before been so confident or so hopeful that engineers can provide leadership, not only in engineering affairs but in civic, economic, and social areas as well. The need particularly of this nation to retain its foremost position in production and in advancing the standards of living and to maintain its democratic institutions, its freedoms, and its rich and varied opportunities for the development of the individual has never been as great as it is now. Upon youth rests a heavy burden; and we can take comfort in the thought that the schools are doing their utmost to prepare young engineers to take up this burden.

Junior members of engineering societies are also singularly fortunate. Before the first World War an engineering graduate, on taking his first job, frequently found it wise to keep silent about his being college bred. Today, the great industrial organizations are bidding against one another for the services of these young men, and an engineering degree is almost an essential to getting a job. Never before have young engineers been so well paid. An increasing number of industrial organizations offer training courses, encourage their young men to work for advanced degrees, and in some instances grant leaves of absence for this purpose. The engineering fraternity, through such organizations as the Engineers' Council for Professional Development and the local, state, and national societies, are deeply concerned with the professional training of recent engineering graduates and afford means by which they may prepare themselves for registration and for self-development.

Youth has much to offer. It has confidence in itself and its destiny. It has energy and enthusiasm. It is rich in idealism. It has courage. Its heart is warm. Particularly in the fields of science and engineering, it contributes many if not most of the new ideas in highly specialized fields. Youth is a season of high productivity and intense activity. It is the season of hope and ambition. But it passes quickly into the season of maturity.

Engineers of maturity have other tasks and other contributions to make to their profession. Theirs is the responsibility of maintaining a going concern, of keeping a rapidly moving world in dynamic balance. In the best of them knowledge has ripened into wisdom; experience has tempered judgment. Their maturity is enriched by a sense of perspective and the spirit of understanding. They have been disciplined in the school of reality, and their matured ambitions, hopes, and confidence are sustained by faith and an acquired sense of values.

In the continuous procession from the season of youth to that of maturity and ripeness of years, the young man of today becomes the mature man of tomorrow. No one, least of all the man himself, knows just when the youth changes into the man, until suddenly it is realized that the change has been made. The change is necessary and inevitable; but the tragedy of living comes when the promise of the youth is not fulfilled in the man, when the maturity is delayed or fails to appear, when the man is sidetracked from the normal growth curve. Avoidance of this tragedy is the responsibility of the man himself, but his colleagues and associates can aid him to discharge it.

It is fortunate for engineering that the national societies are concerned about young men. At the 1947 ASME Annual Meeting President O'Brien took as the subject of his address, "Accent on Youth," and this address, published in our January issue, has been commended by older and younger men alike. Junior Members of ASME are organized, and they maintain a "Junior Forum" in the ASME News Section of this magazine. That forum, too, has been noted with approval by members replying to our reader-interest survey. From both age groups comes testimony to the interest of older men in their youthful colleagues and associates.

One area within which ASME Junior Members are

making a permanent contribution is seldom mentioned. That is the Transactions of the Society. A recent survey of the papers published in ASME Transactions and the *Journal of Applied Mechanics* over a period of three years shows that while men in the Member and higher grades produced 211 papers, Junior Members produced 75. This record is in itself a remarkable tribute to youth and is convincing evidence of the virility of the younger members of the Society. At an early age they have placed their colleagues of all ages in their debt. They have made an auspicious start. Their rate of growth is steadily upward. No one need fear that the sources of our engineering literature will dry up when the Junior Members are thus actively engaged in the writing of technical papers.

It is a good sign when youth is impatient to become mature, when it is restless to cast off the garments and titles of its season to assume those of older men. Perhaps the very name of the grade of membership these young men hold is inappropriate and due for change. Traditionally, these young engineers have been called Junior Members. Is there a paternalistic implication of juvenility about this term which creates a barrier between young men of promise and their more mature colleagues? Surely, the mature man thinks of the young man as an associate, as, indeed, he is in most cases.

This is a question to which the Committee on Professional Recognition of ECPD has been giving study, and the recommendation has been made that the engineering societies discard the term junior member and substitute for it the more appropriate term associate member. If the suggested change will help to convince young engineers that the older members of the profession recognize them as associates or colleagues, it cannot be too quickly put into effect. Whatever the term may be, young and mature engineers are associates professionally.

Clifford B. Le Page

CLIFFORD B. LE PAGE, whose death occurred suddenly on Jan. 15, 1948, while he was attending a committee meeting in Hartford, Conn., had been assistant secretary of The American Society of Mechanical Engineers since 1918. He was in charge of the Technical Department of the Society, and under his supervision were the activities of the Society in the fields of standards, power test codes, safety, and research. At the time of his death he had a staff of 15 persons, and with them was responsible for the work of more than 200 ASME technical committees. The Society's interests in these matters in some 15 other committees and organizations with which the ASME collaborates were also under his charge.

Although the Society began early in its development to engage in what were later to be known as technical-committee activities, by far the major portion of its work in this area was organized and carried out during the 30 years of Mr. Le Page's service. The current list of these technical committees contains only a few, notably the Boiler Code Committee and a couple of standards committees, that were organized prior to 1918. Mr. Le Page's duties involved consultation and guidance during the formative stages of committees, their organization and selection of personnel, supervision of staff service to them, which included the preparation of codes and standards, and constant contact with them to encourage and speed their efforts.

It would be futile to estimate the hundreds of committees and thousands of committeemen who were associated with Mr. Le Page in the important work he directed. It was a work which required energy and enthusiasm to organize and administer, tact and judgment to carry forward, and clear thinking and meticulous care in execution of detail. The broad knowledge of fundamental subject matter which is characteristic of the scholar and the refinement of bearing and behavior which mark the true gentleman were notable qualities which his friends and associates admired in Mr. Le Page, and never failed him, even in the heat of argument and debate.

Mr. Le Page was born in New York, N. Y., was graduated from the Stevens Institute of Technology in 1902, and subsequently received a master's degree from that institution. From 1902 to 1921 he was on the teaching staff of the Institute, first as instructor and later as assistant professor of physics. As assistant secretary of ASME he was active in national and international standardization, codification, and research, and in connection with his work he made numerous trips abroad from 1925 to 1938. During World War II he was a part-time consultant on standardization matters in the Conservation Division of the War Production Board. His thirty years of service have left their mark on engineering progress.

Reader-Interest Survey

AFTER a lapse of several months MECHANICAL ENGINEERING is re-establishing the reader-interest survey which proved to be so helpful to the editors during the first seven months of 1947. Decision to continue the survey was based not only on the value of the initial experience but to get opinions of readers on two features which have been added to the magazine. These are the "Junior Forum," conducted by and in the interests of junior members of ASME, and the "ASME Technical Digest" which was established on the first of the year as a feature of the new ASME publication plan that went into effect on that date.

With the resumption of the survey it is hoped that the response will be as generous and as helpful as it was last year and that the Publications Committee and the editors can get an estimate of the value of the two new features, the "Junior Forum" and "ASME Technical Digest." If you are one of those to receive a card during the next few months, the editors hope you will fill it out so that they may be in a better position to conduct the kind of a magazine you wish to read.

FIG. 1 WEST ELEVATION OF LABORATORY AND POWERHOUSE

A LABORATORY *for* GAS-TURBINE DEVELOPMENT

Significant Features of Facility Operated by Westinghouse Electric Corporation

By WINSTON R. NEW

MANAGER, WESTINGHOUSE AVIATION GAS TURBINE LABORATORY, SOUTH PHILADELPHIA, PA. MEM. ASME

EARLY jet-propulsion engines of the author's company were produced without recourse to development facilities other than those owned by the corporation before the United States entry into the war. In the closing months of 1943, it was increasingly apparent that large additional engineering-development facilities were essential to continued sound pioneering of all forms of gas-turbine motive power. Accordingly, early in 1944, under the sponsorship of the Bureau of Aeronautics, U. S. Navy, the corporation agreed to design, erect, equip, and put into operation a gas-turbine component-development laboratory.

The purpose of this paper is to present significant features and details of operation of this laboratory which is powered and equipped to be a practical working entity of high utility. The selected capacity for component development is large enough to be representative of anticipated average-size propulsion units, and yet small enough to be free of the unwieldiness inherent in test equipment designed for the largest units which may be built.

WHY A COMPONENT-DEVELOPMENT LABORATORY IS NEEDED

The useful output of a gas-turbine power plant is dependent upon the performance at all altitudes of a compact high-heat-release combustor and upon the difference between the large powers handled by the turbine and compressor. Accordingly, it is sensitive to changes in the efficiency of any of its components. Complete engine tests are essential to establish over-all performance, but are of very limited use in analysis of functioning and design improvement of major individual parts.

The compactness of an aviation gas-turbine power plant makes it difficult to obtain reliable single values of fundamental component performance from assembled engines operated on a test stand or in a plane. Extended characteristics of the components are entirely beyond reach in the absence of provisions for separating and independently controlling flows, torques, speeds, pressure ratios, and other prime variables. Progress in improvement requires the availability of facilities for full-speed and high-power testing of separate components under simulated operating conditions. Admittedly, this requires expensive testing machinery of considerable power, and the dissipation of large quantities of heat, but it appears to be the only attractive way in which the required information can be made available. The development of improved gas-turbine propulsion units is therefore very intimately dependent upon the provision of adequate component-testing laboratories.

OBJECTIVES, CAPACITY, AND AVAILABLE POWER

Keeping flexibility paramount in a study of the factors involved, decision was reached on provision for full-scale tests

Contributed by the Aviation Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of The American Society of Mechanical Engineers.

on all components of a power plant of 4000-hp net output. This capacity in no way represented an upper limit of interest to military aviation, nor is it now a practical maximum defined by procurable rotor forgings for simple Joule-cycle machines. More powerful than any aircraft-engine developed as of 1943, the selection appeared big enough to avoid significant scale effect in development tests; and of great importance with regard to time, effort, and material, adequate power immediately adjoined the proposed laboratory site. In Fig. 1 the laboratory is shown at the left, the powerhouse at the right of the stack. Both are properties of the Reconstruction Finance Corporation, U. S. Government.

The powerhouse was erected in 1940 as part of the company's factory expansion under the sponsorship of the Bureau of Ships, U. S. Navy, to meet the needs for steam turbines for the cargo and tanker fleet. It contains two stoker-fired boilers, each rated at 75,000 lb per hr of steam at 600 psig and 800 F total temperature. Over two thirds of this capacity was demand reserve for turbine tests with a low use factor subject to control. It was evident that another load with similar characteristics could be carried on a schedule eliminating concurrent peaks. This, and proximity to large existing underground river-water intakes and discharges fixed the laboratory location and obviated prolonged studies to justify selection of the steam plant for the flexibility of variable-speed turbines over probable lower first cost of electric drives.

LABORATORY GENERAL PLAN AND STRUCTURAL ARRANGEMENT

The laboratory, shown diagrammatically in Fig. 2, contains essentially four functional subdivisions, i.e., (1) high-power turbine, (2) high-power compressor and low-power models, (3) variable-pressure combustion, and (4) accessories, lubrication, and mechanical development. The areas, headroom, craneways, rail, and road connections indicated, convey the physical size of plant, and equipment handled. Notations in Fig. 2 reveal the principal power and cooling requirements with heating steam, sanitation provisions, shop compressed air, etc., omitted.

Support, machinery layout, and operational requirements for the high-power areas form a problem more closely resembling steam-powerhouse than aviation-engine test-cell design. At least two generally acknowledged essentials of the latter-type structure, however, influenced plans and specification for this part of the building. These are segregation of control, observation, and recording of test operations from machinery space, and enforced avoidance of explosion and fire hazard where large flows of volatile fuels necessarily traverse this space.

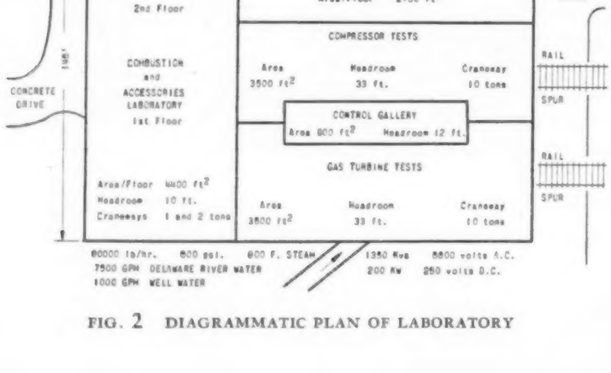

FIG. 2 DIAGRAMMATIC PLAN OF LABORATORY

The remote-control requirement rests on protecting personnel from the dual hazards of development tests unavoidably encroaching safety limits, and intolerable noise. For insistence on this provision early in the planning, we are indebted to our sponsor.

Continuous foundation for the high-power test machinery comprises a surface formed by planed steel rails embedded in three parallel rows of reinforced-concrete bents, 7 ft 6 in. center to center on either side of the control room. The floor level so defined is 14 ft above grade, and all steam, oil, fuel, and auxiliary piping and much of the functional air and combustion-products piping are below this floor level, a condition unobtainable where wide continuous bedplates are used. The cutaway view in Fig. 3 shows the disposition of control room, machinery

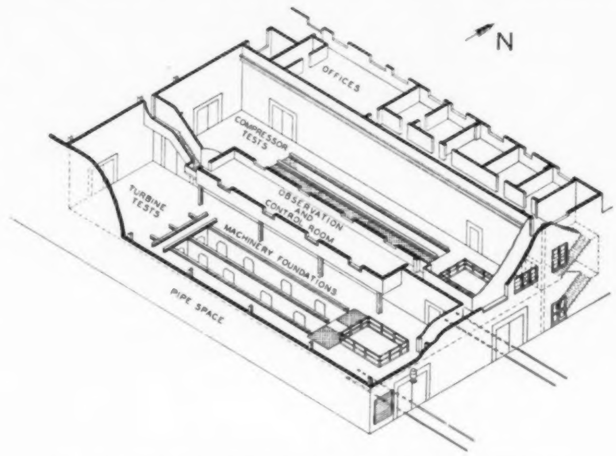

FIG. 3 CUTAWAY VIEW OF GAS-TURBINE DEVELOPMENT LABORATORY

foundation, and piping space, as they would appear from a point above and beyond the upper southeast corner of the building.

The control room is a reinforced-concrete tube 12 ft square inside cross section, supported by the two interior rows of columns. The floor, 8 ft above foundation rails, connects by enclosed passages at either end with both the machinery rooms and offices. The wall is 15 in. thick, including 3-in. interior lining of glass wool, faced with perforated synthetic board. The windows are double panes of bulletproof construction and noise transmission is diminished by soundproof doors.

A scavenging system of capacity equal to the full required ventilation connects with large ducts at grade level along each side of the main machinery beds, defined by the concrete bents. There are screened openings into the sides of these ducts between the footings of each bent. Air from anemostats above the craneways flows through the grating between foundation rails and is evacuated along with any entrained vapors to a sound-suppressed outlet. The use of more cumbersome and expensive explosion-proof motors and controls is confined to the space beneath the main floor without sacrificing safety.

HIGH-POWER TURBINE TESTS

The major machinery is arranged as indicated by diagram in Fig. 4. The two multistage wide-speed-range steam-turbine-driven compressors run individually or in series with intercooling up to a total input of 9400 hp to compress approximately 58 lb per sec of air from a sound-suppressed intake to 118 psia. This motive air passes through suitable metering and valving means to a large combustor wherein the burning of fuel oil, over a 20-fold range of heat-release rates to a maximum of 85,000,000 Btu per hr, provides combustion products at pres-

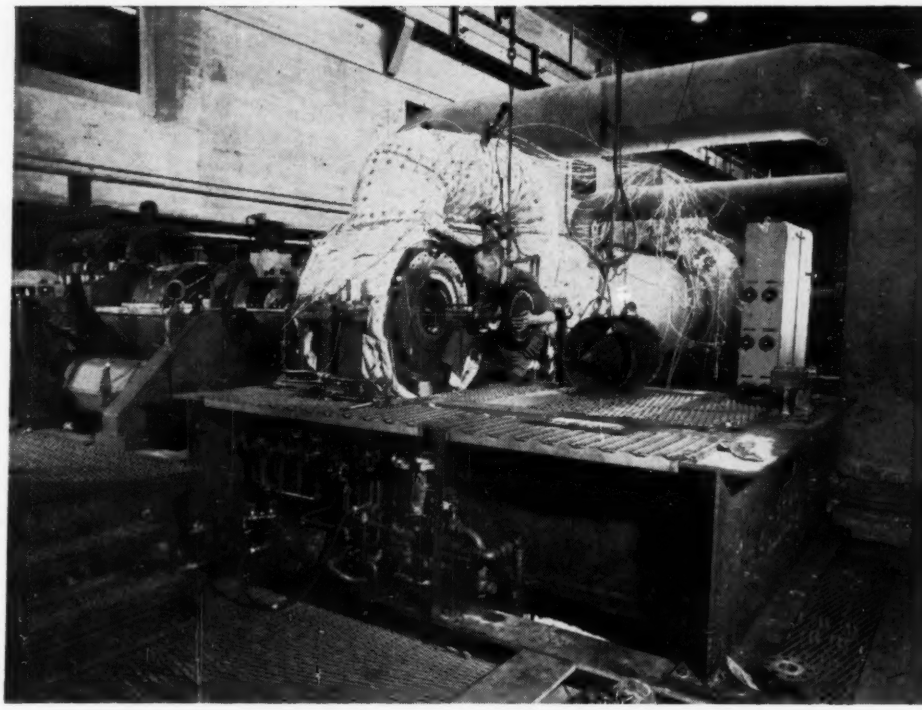

FIG. 5 GAS-TURBINE HOUSING AND WATER BRAKE

sures up to 8 atm and temperatures up to 1800 F for the gas turbine on test. Gas-turbine outputs, here undiminished by a factor of 3 or 4 as when pumping their own air, approach 18,000 hp at speeds up to 15,000 rpm. Maximum and lower power at speeds up to 20,000 rpm are absorbed by controlled-torque water brakes. Exhaust from the turbine at substantially atmospheric pressure passes to the fire-brick-lined sound-suppressed breeching and stack in Fig. 1. Independent metered-air-discharge line and by-pass from the 2:1 compressor, and intake to the 4:1 compressor, omitted for clarity in Fig. 4, have been provided.

The partly assembled experimental gas-turbine housing central in Fig. 5 is fabricated in three sections from 19–9DL forgings and plate bolted at two vertical joints. For single- or twin-stage jet-motor turbines, the test element, including internal bearing and supports, nozzle blocks, or diaphragm and stationary blade rings, is carried overhung from the inlet section, as shown, and expands freely into intermediate and discharge sections of the housing removed to obtain this photograph. The anchor point in the common central plane of test cylinder and combustor is near the intersection of the vertical center line of the split inlet pipe and the high-speed shaft. The three webs of the unique support are selectively pitched to resist forces exerted by the combustor in a transverse direction, and test cylinder in an axial direction, while accommodating radial expansion. The small pipes in front of the bedplate supply and scavenge oil from the internal gas-turbine bearings. Also included is a differential air seal developed to prevent leakage around the gas-turbine shaft.

The torque-measurement provisions command special attention. Absorption dynamometers are supplemented with magnetic torquemeters inserted interchangeably with simple shaft couplings between driving and driven elements The brake on the left in Fig. 5 is the larger of two units, each containing a pair of rotors driven in parallel through a central single-reduction helical pinion to gears on the rotor shafts. The larger brake has three sets of interchangeable gears for pinion to impeller speed ratios of 2, 3, and 4 to 1, and absorbs up to 18,000 hp at turbine speeds of 15,000 rpm. The rating of the smaller companion brake is 4000 hp, and both can accommodate turbine speeds up to 20,000 rpm. The rotors, bearings, and seals are nested in fabricated upper and lower casings cradled in slow-precession roller bearings. Casing rotation is opposed by hydraulic pistons. Movement of a small sensitive position relay with the brake arm increases or diminishes torque pressure on the main piston to restore equilibrium. The oil pressure is used as both an indication of torque and as a control pressure for positioning the water-discharge valve. The maximum water demand of 1000 gpm at 200 psi pressure is supplied by three wells through an outside storage reservoir and pumping station. Independent hydraulic and electrical overspeed trips are incorporated in the control system. The water valve, fuel and air throttles, and air by-pass valves, are tripped simultaneously by either of these safeguards to their emergency positions if the gas turbine overspeeds.

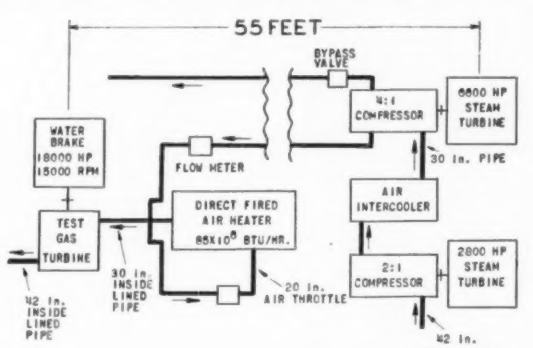

FIG. 4 GAS-TURBINE TESTS—FULL SPEED AND HIGH POWER

The direct-fired main air heater, furnished to our specifications by the Peabody Engineering Corporation, was patterned in principle and appearance from successful oil-refinery installations, but designed to deliver hot gases over wider ranges of fluid pressure and temperature. The fuel nozzle burns Nos. 5 and 6 grade oil with 250-psi steam atomization, electric spark ignition, and photoelectric-cell flame-continuity protection. Atomizing steam purges the chamber after emergency interruptions of fuel and air supply. Fuel flow, measured by an armored remote-reading rotameter, is controlled by a temperature-responsive throttle and shutoff valve.

The two steam-turbine-driven compressors occupy the foreground in Fig. 6. The machine on the left contains nine stages designed to develop a compression ratio of 2 when intaking approximately 45,000 cfm at a speed of 6100 rpm. The machine

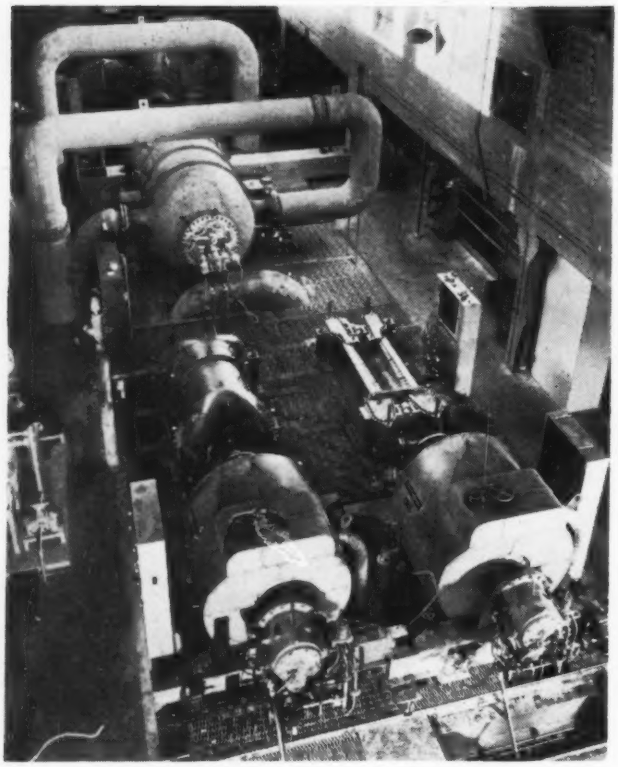

FIG. 6 AIR COMPRESSORS AND HEATER FOR GAS-TURBINE TESTS

with cover removed on the right contains 24 stages, designed for a compression ratio of 4, running at a speed of 7750 rpm. When this compressor receives the rated supercharged and intercooled output of the 2:1 machine, its power requirement is just within the 6600 bhp capacity of the drive. The 4:1 unit may also be operated entirely independently of the 2:1 unit at speeds up to 9000 rpm. Both steam turbines have special thrust bearings and are equipped with wide-range speed-changer hydraulic governors actuating external single-valve steam chests.

Three of the four, balanced, double-seated, motive air throttle valves, developed to our specifications by the Atwood-Morrill Company, are remotely positioned by torque-limiting drives, and the fourth by an oil-operated piston. Hydraulic trip mechanisms function at any point in valve travel, at the will of the operator, or in response to an overspeed signal from the gas turbine on test. The flowmeter in the high-pressure circuit, supplied by the Bailey Meter Company, is a 20-in. adjustable orifice with 8 pneumatically operated stops ranging from 15 to 85 per cent full pipe cross section. The flowmeter in the 30-in. low-pressure air circuit is a standard nozzle with favorable approach conditions. Thermal expansion in both high- and low-pressure circuits was a major design problem, solved by the incorporation of many multiple-diaphragm expansion joints which permit considerable bending, will not separate axially under pressure loads, are entirely elastic, and contain no packing or sliding surfaces of any kind.

All major machinery elements and auxiliaries affecting test variables are directly operable from the main floor and remotely operable from control-room console-type desks and panels shown in Fig. 7. To establish and maintain preassigned running conditions to the direction of the test engineer, the operators have continuous indication of turbine speed, all pressures, valve positions, gas and bearing temperatures, vibration amplitude, spindle and cradle positions. Principal controls and safeguards are interlocked to prevent mutually exclusive operations. A two-way communication system between control room and machinery floor is provided. More detailed and precise measurements are made on the panel-mounted instruments.

HIGH-POWER COMPRESSOR AND LOW-POWER MODEL TESTS

For full-speed high-power tests of compressors alone, equipment indicated by diagram in Fig. 8 is in use. Few or many compressor stages, installed in the parted corner of a closed circuit of 36-in-diam pipe, are directly close-coupled to the steam-turbine dynamometer. The limitations are 6000-hp rating of the drive; an upper speed of 20,000 rpm; compressor outlet pressure of 150 psi or inlet pressure of 90 psi, separately or in any combination. Length and cross section of the circuit, including shell and finned-tube cooler dissipating all input energy to water, meet requirements of low resistance and nearly ideal fluid distribution ahead of the test compressor and Bailey 8-position variable-area orifice. A closed circuit affords flexibility through control of the pressure level partly lost with an open circuit and an intake throttle. Suspension in a vertical plane between continuous foundation rails freed the machinery floor of elements requiring only periodic maintenance.

The experimental compressor housing, central in Fig. 9, is a heavy cylinder parted at the center line and at two vertical joints, and a large but very compactly designed end bell with bottom discharge. In addition to carrying the internal static pressure of the circuit, the housing provides a universal support

FIG. 7 CONTROL ROOM FOR FULL-SPEED AND HIGH-POWER TESTS

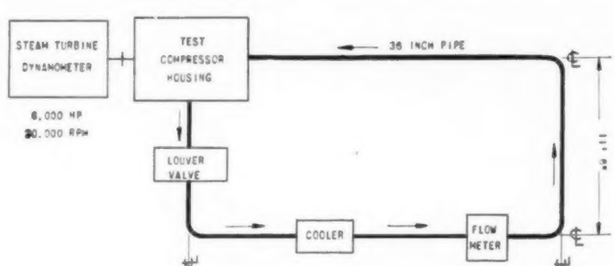

FIG. 8 COMPRESSOR TESTS—FULL SPEED AND HIGH POWER

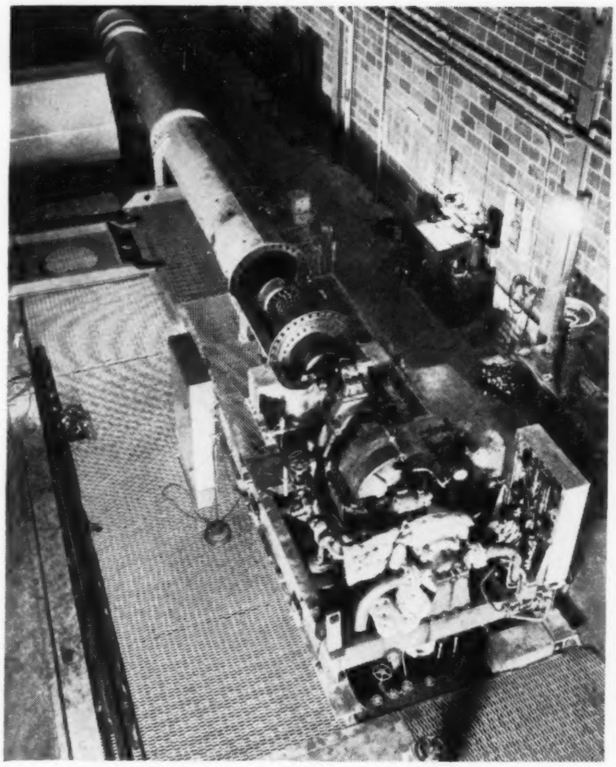

FIG. 9 EXPERIMENTAL COMPRESSOR CIRCUIT AND DRIVE

for stationary members of experimental compressors and many seals, such as those through which pressures and temperatures, measured by automatic stage traversing equipment, must pass. When operating with atmospheric inlet pressure, the cover may be removed. The instrumentation terminus for all long lines from the control room is at the left of the bedplate in Fig. 9. Short and easily changed connections are made from this indexed panel to the unit on test. An independent lubrication system supplies and scavenges the upstream compressor bearing under the full range of pressures obtainable in the circuit.

The steam dynamometer, right foreground in Fig. 9, is a Curtis reaction machine incorporating numerous specialties. Rated at 6000 hp at 10,000, and 20,000 rpm, the unit develops in excess of 7000 hp at more efficient intermediate speeds. Below 10,000 rpm, power output is limited by a torque of 3150 ft-lb. To pass the maximum steam flow of 67,000 lb per hr through a single exhaust annulus, the vacuum for all steam turbines in the laboratory was restricted to 5 psi. Even so, a maximum blade-tip speed of 1570 fps is reached at 20,000 rpm. Low exhaust moisture content, and low total operating time at maximum speed make these design conditions tolerable. Spindle, bearings, and stationary blading are all enclosed in a fabricated cradle supported by slow-precession roller bearings. High-pressure steam enters the cradle through a ported tubular extension into a labyrinth-sealed tee. Steam exhausts through an elongated elbow completely encased in a symmetrical chamber with labyrinth-type vacuum seals. Both the inlet and exhaust seals are coaxial with the spindle and vented to the steam condenser. The exhaust elbow is designed to eliminate appreciable moment from the exit reaction.

The torque of the freely supported stator is opposed by oil pressure on a piston with sensitive relay. This pressure is used for both torque indication and control, acting together with a second oil pressure from a speed-sensitive element, on the steam governor valve. Provision is made to hold a preassigned torque and count revolutions for a measured time to give the most accurate determination of power with the speed control overriding the torque control for safety at marginal settings. Additional, independent, hydraulic and electrical overspeed trips close the steam throttle valve, which is in series with but independent of the governor valve in event of normal control failure.

Another unusual feature of the steam dynamometer is its automatic spindle thrust-balancing mechanism. Turbine and test compressor are thrust opposed with residual carried by the turbine thrust bearing. This residual thrust, at times reaching thousands of pounds, would tend to jam the cradle bearings against the supports and reduce torque sensitivity. To overcome this, a balancing force has been provided on the cradle through the use of a position-sensitive relay and steam dummy piston. The relay regulates pressure drop across the dummy piston in response to spindle end travel to hold the cradle nearly thrust neutral.

The throttle valve, supported by the rectangular discharge flange of the test-compressor housing, is a multiple-louver type designed for sensitive control, good flow distribution, and minimum resistance when wide open. An external gear motor and linkage turns six uncambered blades in pairs, in a selected sequence. The maximum pressure drop is 60 psi. Alternate blades rotate in opposite directions through an arc of 60 deg to form constrictions approaching closure along lines near their

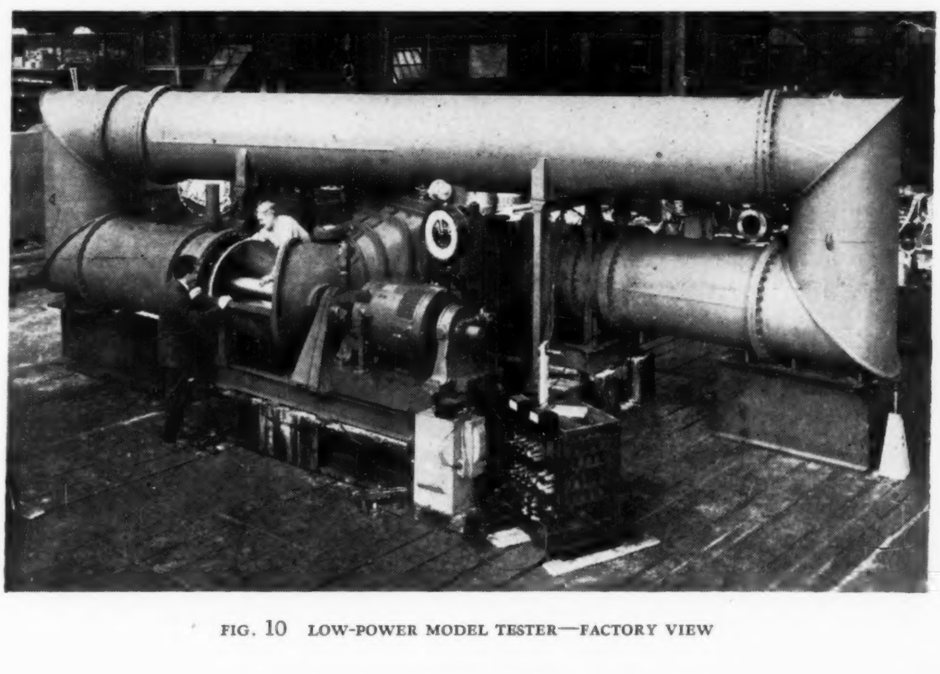

FIG. 10 LOW-POWER MODEL TESTER—FACTORY VIEW

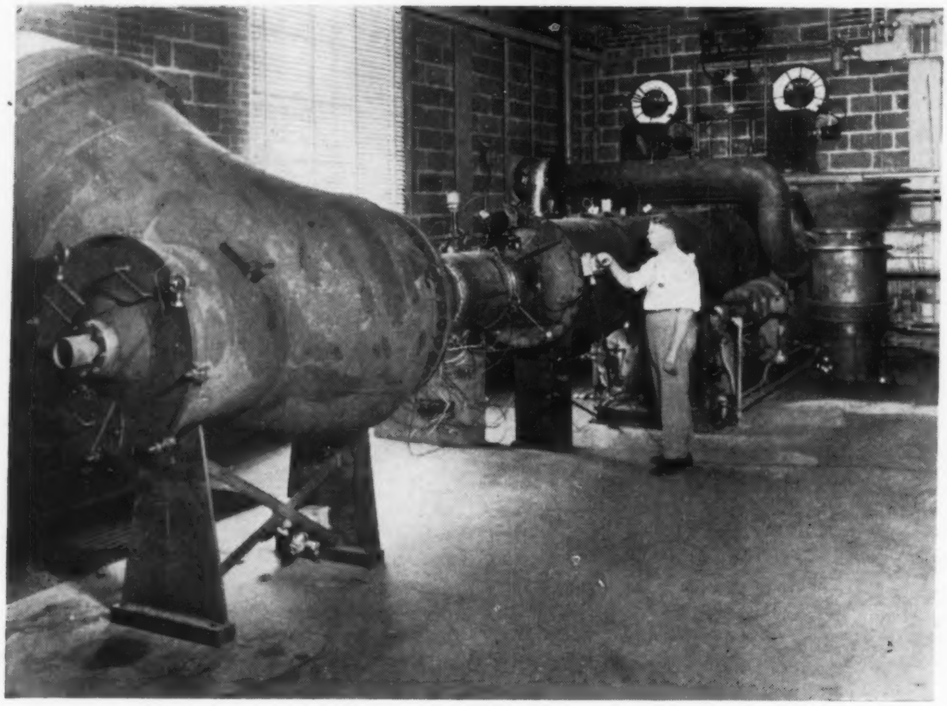

FIG. 12 ALTITUDE AND ATMOSPHERIC-PRESSURE EXPERIMENTAL COMBUSTOR STAND

leading and trailing edges. There is no need for this valve to be gastight. Test-compressor inlet pressure is manually established but automatically maintained with a sensitivity of ±0.5 in. of water over the range of 4 to 90 psi. Below atmosphere steam ejectors evacuate system leakage and the controlled make-up.

Operation and control of the steam dynamometer, all major elements of the circuit, and auxiliaries affecting the test variables may be performed remotely from the relative quiet and safety of the control room or directly from the main floor when more convenient and nonhazardous. The general arrangement and appearance of control desks and panels is similar to that pictured and described for the high-power turbine test area.

The low-power model tester, shown in Fig. 10, erected in our factory before delivery to the laboratory, contains all the functional elements of the high-speed plant previously described. It differs mainly in capacity and apparatus arrangement. Symmetrical about a vertical line through the center of the shell-and-finned-tube cooler, this installation is disposed wholly above floor level within the service area of a 2-ton craneway.

Operated as a feeder facility to the full-scale plant, this tester is used to screen work on single- and multiple-stage assemblies systematically embracing changes in every design variable excepting Mach number. To this end, no efforts have been spared to promote operational convenience and high use factor. Selection of 36-in. pipe size, speeds, powers, and pressures from 4 to 90 psi preserve the objective of using large models to suppress dimensional inaccuracies, made of metal, wood, or plastics with simpler blade fastenings than those required on high-stressed prototypes.

Two 50-hp d-c dynamometers, mounted at the inboard end of the test sections, carry single or multiple stages on extended shafts and torque tubes and may drive or be driven in either direction at speeds up to 5000 rpm. The metering orifice in the overhead pipe is shifted from one end to the other to accommodate flow direction. When testing a turbine model, a stock compressor is driven by one dynamometer to provide the motive stream. Likewise, this may be required when extending a compressor test to pressure ratios so low and flows so high that even the very low circuit resistance otherwise takes control away from the louver valve. Operations are conducted from panels bordering a portion of the same room that houses the tester; hazard and noise being of low order here by contrast with the high-power test areas.

VARIABLE-PRESSURE COMBUSTION TESTS

Minimum weight, low pressure drop with complete combustion, uniform flow, and temperature distribution both circumferentially and radially, short length, long life with minimum accumulation of deposits, and a maximum range and upper limit of heat-release rates with stable burning—these collectively, but with emphasis varying with application—are the

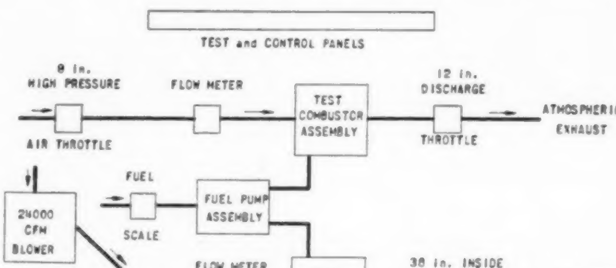

FIG. 11 COMBUSTION TESTS—SEA LEVEL TO 45,000-FT-ALTITUDE EXHAUST

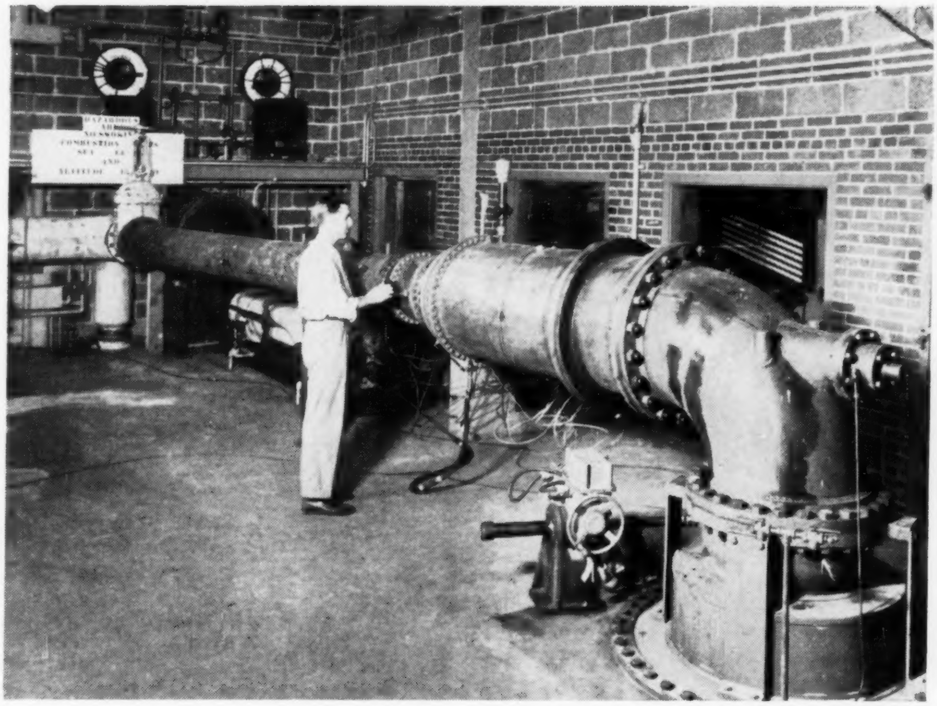

FIG. 13 HIGH-PRESSURE EXPERIMENTAL COMBUSTOR STAND

requirements of an aircraft combustion chamber. Many pairs of the factors broadly stated are mutually conflicting. Experience accumulated prior to and during design of this laboratory yielded no completely satisfactory means for extrapolating widely the limited range of combustor-performance data obtainable with a simple fan for an air source. Provision was accordingly made for combustion tests on three major types of assembly indicated by diagram in Fig. 11.

For the first type, a single-stage blower, delivering 24,600 cfm at 39-in. water pressure, affords preliminary comparison of combustion chambers of varied configurations. This is also used to examine velocity distributions through subassemblies, prior to preparation for firing. For the second type, compressed air from the high-power plant of the turbine laboratory provides for tests at elevated pressure. For the third type, through another use of the main compression plant in conjunction with a water-jacketed shell-and-tube cooler, dissipating up to 11,000 Btu per sec to reduce gas-outlet temperatures to 100 F, provision has been made for simulating flight pressure conditions in the test combustion chamber up to 45,000 ft altitude.

A typical installation made up of 30-in-ID pipe for altitude and atmospheric-pressure tests appears in Fig. 12. At eye level on the turn of the inside-insulated exhaust elbow, and coaxial with the combustor, is a high-temperature window permitting inspection of combustor operation. At shutdown, the plate supporting the window can be removed to inspect burner deterioration or accumulation of deposits without dismantling the setup. For altitude testing, the exhaust elbow is oriented as in Fig. 12, to connect with a water-cooled pipe passing through the wall of the laboratory to the externally mounted water-walled shell-and-tube cooler. Air intake from the atmospheric blower room behind the fuel scales is throttled, and the cooled combustion products are evacuated by the multistage compressors previously described. For atmospheric tests, it is only necessary to rotate the exhaust elbow to discharge vertically downward through a firebrick-lined breeching to the stack, and to connect the blower in place of the throttle valve at the test-stand inlet. An over-all craneway promotes easy handling of the relatively large pieces of pipe.

For pressurized testing, two 8-in. remotely operable balanced throttle valves in the pipe space below floor level control the flow of high-pressure air from the main compressors to an assembly illustrated in Fig. 13. Smaller-diameter heavier-walled metering section, and smaller inside-insulated exhaust elbow replaced those provided for low-pressure work. A motorized back-pressure control valve, designed to our specifications by the Atwood and Morrill Company, to hold 100 psi at 1500 F, supports the smaller exhaust elbow to the flange of the exhaust breeching set flush with the floor.

Remotely operable primary supply pumps deliver gasoline, kerosene, or fuel oil, the latter heated by steam-traced lines to 140 F, from underground storage via the pump house, to the Toledo weight-rate scales in the background of Figs. 12 and 13. A 10-lb or 50-lb scale may be selected, depending upon flow rate. Fuel measurement, from 40 to 5000 lb per hr, is accomplished by sample weight-selector and cycle-initiation switches. Photoelectric cells at the scale dials start and stop the timer to define the flow interval for the chosen sample. High accuracy can be attained when the measurement cycle is as short as 1 min. The advantages of the method are flexibility and controlled accuracy when using liquid fuels of any density or viscosity.

Fuel flows from the scale tanks at a constant head to two variable-speed motor-driven pump-and-heater sets under the test stands in Figs. 12 and 13. Each set can deliver to a test combustor 3200 lb per hr of gasoline or kerosene at ambient temperature and maximum pressure of 500 psi or 5000 lb per hr of fuel oil at temperatures up to 300 F and pressures up to 1000 psi. During starting, the fuel flow is regulated manually by an air-operated throttle valve, while the ignition transformer is momentarily energized. A differential relief valve holds constant pressure across the throttle valve to insure good control and eliminate excess pump input to a small quantity of recirculated fuel. Other by-passes to the return lines make it pos-

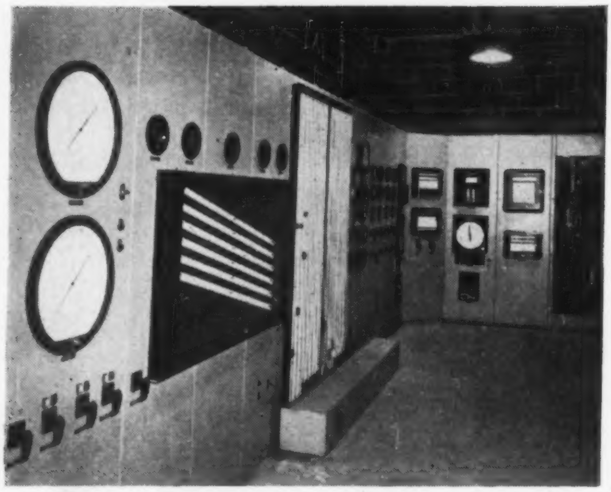

FIG. 14 CONTROL ROOM FOR COMBUSTION TESTS

sible to establish stable operation of the heater before firing a combustor with heavy fuel. If for any reason flame is extinguished, fuel to the combustor is automatically cut off to prevent unintended reignition and perhaps explosive burning. When flame is established, a switch from manual to automatic fuel throttling can be made to maintain any desired discharge temperature between 200 F and 2000 F.

The combustion laboratory is equipped with explosion-proof machinery and fixtures throughout and is protected by a water-fog system triggered by heat-actuated pickups. Forced ventilation from above the craneway and thorough scavenging from below floor level resemble provisions previously discussed. Control and measurement of test results are accomplished from the panels shown in Fig. 14. To permit use of nonexplosion-proof controls and instruments, as well as to promote safety, efficient operation, and comfort, the switchboard is located in a room adjoining and overlooking the test area, with all interconnections terminated in instrumentation bulkheads adjoining the test stands.

ACCESSORIES, LUBRICATION, AND MECHANICAL DEVELOPMENT TESTS

Independent stands equipped with flexible power units are the basic provisions for many types of tests. One row of these stands in the mechanical laboratory is shown in Fig. 15. In the foreground, electric dynamometers operated on regulated voltage provide wide speed ranges for pump investigations. Controls and some instrumentation are on the panels adjoining the stand. Additional instrumentation, installed on multiple-purpose caster-based desks, can be moved readily into place as needed. Conveniently located valved outlets furnish manufactured gas, compressed air, vacuum, 5-psi steam, water supply and drain, and lubricating-oil drain. Electrical services include 440-volt 3-phase, 208-volt 3-phase, 110-volt single-phase, 250-volt d-c, 24-volt d-c, and variable-frequency power up to 600 cycles is available on three test stands. Further to promote flexibility of attachment to accessory drives, extensive use is made of interchangeable AN mounting pads and spline couplings.

Driven from the 600-cycle source, specially developed machines in the background of Fig. 15 subject sleeve or antifriction bearings to simultaneous conditions of speed, loading, and temperature, exceeding those anticipated in service. A four-pole 20-hp motor provides speeds up to 18,000 rpm, and a two-pole 7-hp motor extends the limit to 36,000 rpm. Resistance elements wound around the bearing housing establish operating temperatures up to 600 F. Cyclic or constant thrust loads of 20,000 lb, and radial loads up to 12,000 lb are obtained by hydraulic pistons. Bearing misalignment is measured and controlled as a test variable. Sudden increase in measured torque, usually indicative of test-bearing failure, automatically interrupts power.

Adjoining the combustion laboratory in an explosion-proof room are facilities for tests requiring circulation of large quantities of gasoline or other very volatile liquids. Projects on governors, fuel pumps, fuel and lubricating systems, and spray nozzles are conducted here at sea-level ambient, and within an altitude chamber. The stand on the left in Fig. 16 provides for rapid evaluation of governor performance. The 15-hp driving motor is Ward-Leonard controlled for wide speed range and specially equipped for close regulation from no load to full load.

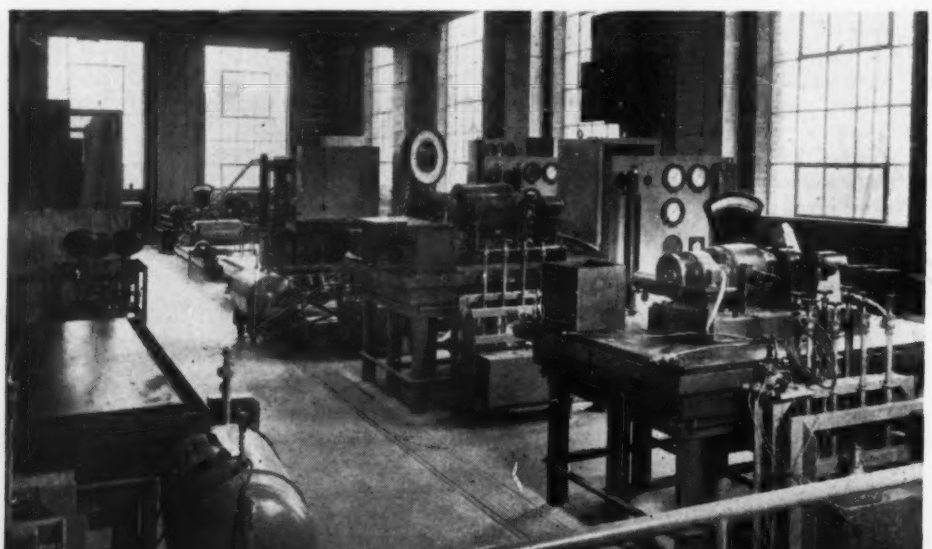

FIG. 15 ACCESSORIES AND MECHANICAL DEVELOPMENT TEST STANDS

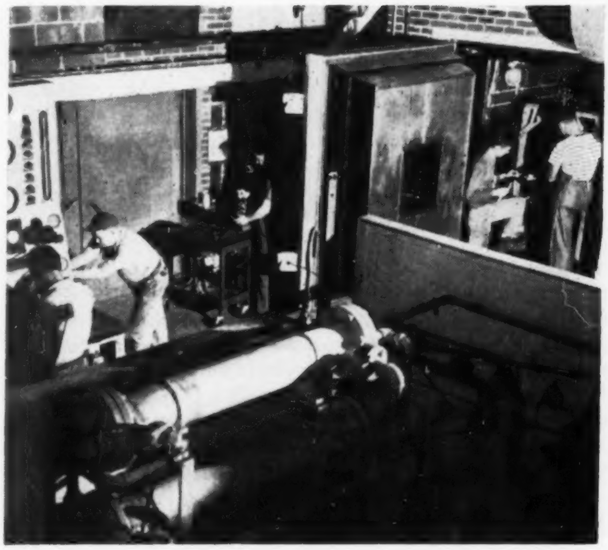

FIG. 16 EXPLOSION-PROOF TEST STANDS AND ALTITUDE CHAMBER

A neighboring installation is powered by a wide-speed-range governor-controlled steam turbine with step-up transmission delivering 125 hp up to 12,500 rpm, sufficient for qualification tests on completely assembled jet-motor-gear packages loaded with a full complement of accessories.

Just visible through the open door on the right in Fig. 16 is the $6 \times 6^1/_2 \times 7$-ft working space of the altitude chamber wherein pressures from sea level to 70,000 ft, temperatures from −67 F to 158 F, and controlled humidity in any combination are maintained by machines outside the explosion-proof area. A shaft, centrally located through the rear wall of the working space, from an external motor, controlled as described for the governor stand in the preceding paragraph, delivers or absorbs up to 50 hp and 10,000 rpm.

On the ground floor, better to accommodate the special hazard involved, are facilities shown in Fig. 17 for mechanical tests on bladed disks. The control room, similar in appearance to Fig. 14, but smaller, overlooks the test area from the right in Fig. 17. The specimen is driven, to destruction if desired, in the 46-in-diam × 41-in-deep evacuated shell below ground level. The shell is successively encased with lead brick, laminated steel armor, and reinforced concrete. The lead brick holds fragments for examination otherwise lost in secondary demolition from the burst disk.

The disk attached to a vertical shaft in guide bearings, is suspended through a shearing pin from the rotor of a small specially constructed compressed-air turbine, safely operated alone to a speed of 60,000 rpm. Within wide limits, power output of the turbine is adjusted to test requirements by control of pressure in the partially evacuated shell. The diaphragm-actuated throttle valve feeding compressed air to the turbine is automatically positioned by a voltage varying with speed from the tachometer generator. An adjustable overspeed trip, furnished with the tachometer, prevents turbine runaway.

The disk encased with insulation is radiantly heated from wire-wound resistors circumferentially spaced, above and below the blades, and selectively cooled by radiation to water flowing in spirally wound tubes close to the plane of the disk on both sides. Service radial temperature gradients may be simulated and measured along with speed and dimensional growth. Calibrated radiation pyrometers are used to measure disk temperature at several radial stations from center to rim. Thermocouples in the cavity close to the disk are used when investigating materials at constant elevated temperatures.

VARIETY WORKSHOP

The single-story portion at the left of the laboratory building in Fig. 1, and top of the diagrammatic plan in Fig. 2, is a well-equipped variety workshop. The interior view in Fig. 18 displays a wealth of general-purpose power tools and equipment seldom equaled in any shop of similar size. Served by a 3-ton full-powered craneway over-all, approximately 50 per cent of the 65 major installations, exclusive of handling equipment, are machine tools, 30 per cent are fabricating and welding machines, 10 per cent are woodworking tools, and 10 per cent are precision-measurement and balancing machines. A crib well stocked with hand tools, welding attachments, cutters, and grinding wheels of many sizes and varieties has been provided. With this complement, to meet no other needs than those of the test areas, it is possible to make, in a minimum of time, anything from a small wood fairing to a complete combustion chamber or high-speed rotor, including machined alloy-steel blades, and to do this without the usual interference with other important activity.

OPERATIONS

The test areas went into service as completed and have now operated for periods ranging from 6 months to nearly 2 years. Exclusive of the powerhouse, where boilers are attended on a three-shift 7 days per week basis, current use of the laboratory on one shift requires the full time of from 60 to 65 persons falling principally into three equal groups. Program and responsibility for methods resides with the engineers, assisted by a few expert draftsmen and several production-procurement clerks. A second group are the mechanics who erect and dismantle test

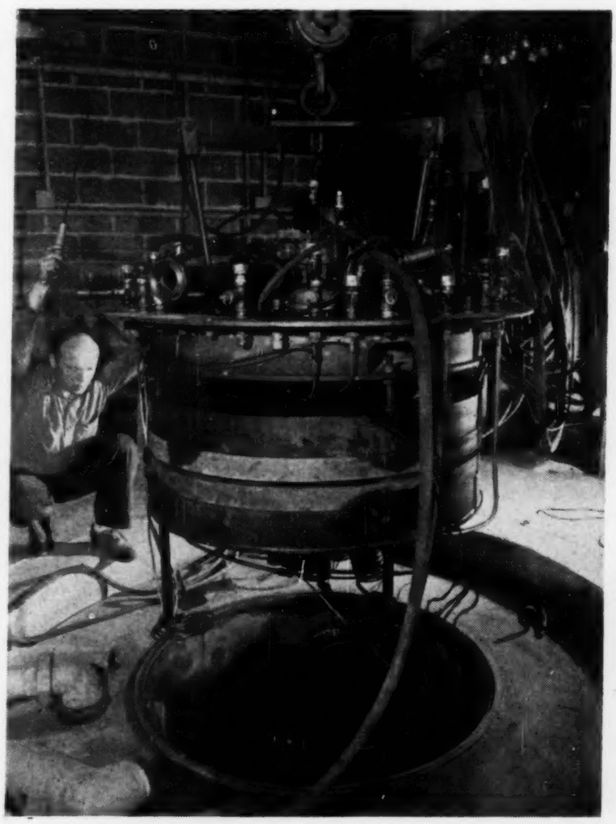

FIG. 17 DISK TEST PIT

equipment of all kinds and assist engineers in the operation thereof. The third group are the model-shop craftsmen of diversified skills who make and modify gas-turbine parts of all kinds needed for test. In addition to full-time personnel, engineers having other assignments come to the laboratory to assist on the projects involving their specialties, to analyze and compute data, and to prepare reports.

It would seem unrealistic in reviewing the establishment of unusual facilities to omit reference to troubles and how they have been overcome. Total operating experience is brief for adequate perspective, but serious difficulties to date have been few. The first high-power-compressor project, a combination test of the compressor and operational shakedown of the plant, was rather remarkably uneventful. With a larger flow, on the second compressor, but well within the range contemplated, the noise level in the room at a well-defined frequency and vibration amplitude of the short drive shaft became intolerable. By operating with various sections of the circuit removed, the cooler was found to be the source of the noise. Investigation and solution of this problem by compartmentation to eliminate a cavity resonance might well be a subject for another paper.

The chimney breeching was not designed to support internal pressure. Even with flame-continuity protection, the possibility of explosions led to the provision of a large panel of unbonded brick midway between the inlets and the base of the stack. Dislocation of a portion of the arched top, recently discovered and corrected before it collapsed, has been attributed to a local puff too remote from the loose panel and of the occurrence of which we were unaware. Positive scavenging of the full length of the breeching from a separate fresh air source has been a recommended alternative to distributed explosion doors.

Early in 1947, a temperature maldistribution in a combustion chamber released for production was found sufficiently extreme to halt preparations for type test of an engine. Twenty-one full-scale liner modifications and laboratory tests within 2 months revealed a solution of minimum complexity immediately incorporable by the factory. For full-speed- and high-power-component tests, preparation exceeds actual running time to the extent that a forecast of 500 test hours per year for turbine and compressor facilities combined seemed somewhat optimistic. In the first 8 months of 1947, however, 300 effective hours on two currently most important compressors had been reached, and the turbine plant passed preliminary shakedown running in June with the principal allocation of this air supply then to combustion tests.

Current program, while considerably more fundamental than performance evaluation of completed jet-propulsion units, should not be classified as research; it is engineering development of power-plant components at full scale wherever necessary, and within limitations of the facilities described. With few exceptions, operations are stimulated by the compulsion that only the ever-present demands of an active manufacturing enterprise can maintain. This together with forward-looking engineering and uncompromising insistence on quality is as wholesome for gas-turbine development as for any other comparable endeavor.

From the viewpoint of a position already enriched by some operating experience, we are convinced that continued effective use of this laboratory in the development of components will take most of the guesswork out of how complete gas-turbine units perform, and thereby speed their adoption as reliable and superior power plants.

ACKNOWLEDGMENT

It is a privilege and pleasure to acknowledge self-sacrificing effort by the author's staff, many engineers, and fellow workers too numerous to mention individually, who have made this laboratory a reality. The credit for many creative contributions in diverse fields belongs to others. No less important has been the perseverance irrespective of difficulties which characterized execution of details. The author sincerely hopes that this record of the accomplishment fulfills its purpose equally well.

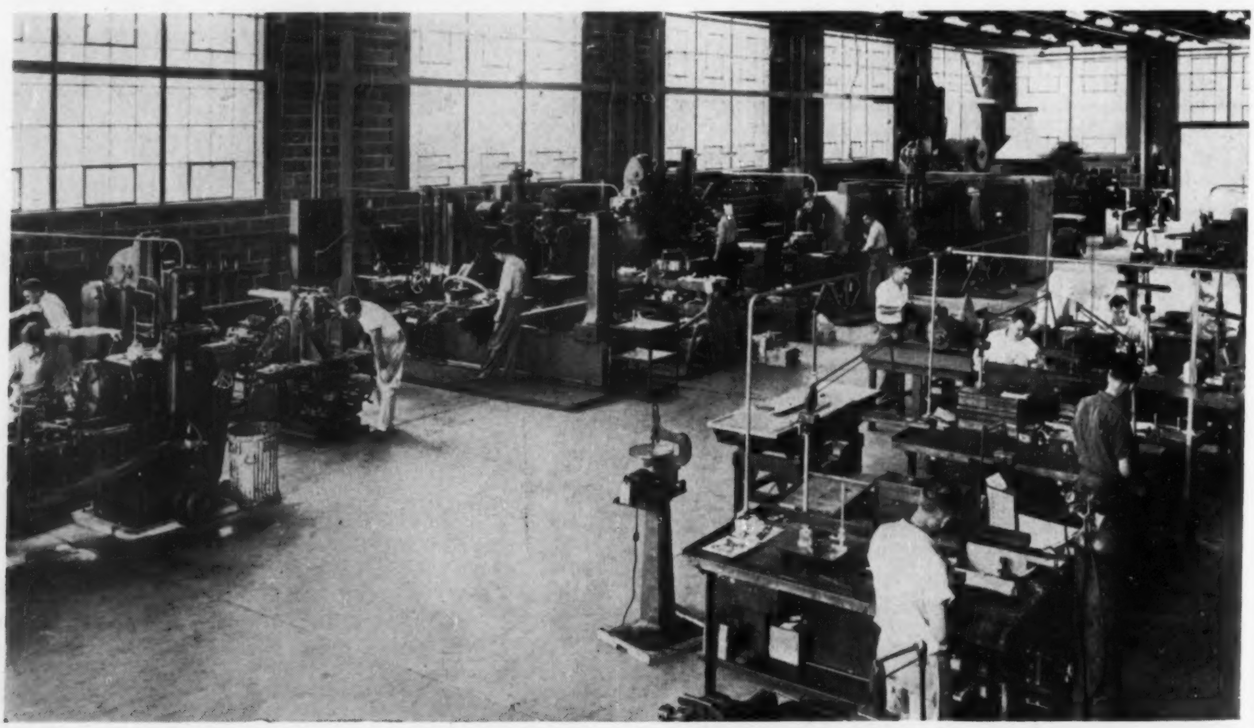

FIG. 18 MODEL SHOP LOOKING EAST

Some ENGINEERING ASPECTS *of* QUALITY CONTROL

By A. G. DALTON

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PRIOR to the development of quality-control methods and techniques, industrial management was handicapped in making decisions involving considerations of quality, because of the intangibility of the subject. These techniques have made it easier for management to make wise decisions in matters concerning the cost of quality and the value of quality by providing a scientific method of measuring and recording quality. Some of the engineering considerations involved in applying these techniques will be discussed in this paper.

WHAT IS QUALITY?

At the outset, it will be well that the terms "quality" and "better quality" are understood. Walter A. Shewhart, in a book[1] published in 1931, devotes some 20 pages to defining quality in its many aspects. While we need not go into the subject to the same extent for purposes of this discussion, we should realize that we are dealing with a word which has many shades of meaning.

There are two basic and important concepts of quality. One of these applies to a reality entirely independent of relationship to anything else or to our needs and wants. The other and most common concept of quality, has to do with how we react as a result of contact with real or objective quality. This latter concept of quality is usually measurable in terms of the utility or need of the physical properties of anything. It is necessary that we recognize the difference between these two concepts and concentrate on the latter if we are to satisfy the people who will use our products.

How are we best satisfied? We need general satisfactoriness of course in a broad sense, but the factors of adequacy, dependability, and economy also tend to influence our over-all opinion as to the satisfactoriness of things. The emphasis that is placed on each of these factors will, of course, vary quite widely, depending upon the nature of the product. Broadly, we may assume that there are two divisions of product—durable and consumable—and our engineers, in writing specifications, must have in mind the relative emphasis that should be placed on each of these "useful" quality factors.

CAUSES AND CONTROL OF VARIABILITY

In many instances a high degree of uniformity and interchangeability is of paramount importance. Even in those cases where the need for interchangeability is not obvious, we still find that people are creatures of habit and react favorably to consistency. We prefer that the things with which we come in contact, and with which we have been satisfied, look the same, feel the same, or behave the same each time we come in contact with them. If they differ to a recognizable degree from kindred products with which we have been satisfied in the past, we are inclined to be skeptical of their quality.

Unfortunately, it is impossible to make two or more things exactly alike however hard we try. When we are striving for customer satisfaction and approval, even in things which may vary one from another quite a bit without much danger of these differences being detected, we try to keep them as much alike as practicable. When we are dealing with more precise measurements and characteristics, and when a high degree of interchangeability is needed, it behooves us to call on all available resources to keep the variations to the required minimum. Apart from the customer's reaction, too much variability between the parts, particularly in complex products, can cause us many headaches and unnecessary expense in subsequent assembly operations.

With any manufacturing process there will be two causes of variations which contribute to differences between units of completed product. One of these causes is the inherent limitations of the production setup, namely, uncontrollable variations in materials, machines, and human beings. If they are uncontrollable, these may be catalogued as chance causes. They are dependent upon such conditions as minor temperature changes, permissible wear of tools, chance relationships between tools and materials, and the operators' working conditions, health, or even frame of mind. Another cause of differences is not due to chance, but to assignable causes which can be eliminated and which should be eliminated, provided such action is economically feasible.

Quality-control techniques permit management to recognize the presence of and thus limit the effect of these assignable causes. Once recognized, the cost of reducing the effect of them can be weighed against the advantages of greater uniformity of product. The author does not wish to create the impression that this latter operation is as simple as it may sound. It involves a comprehensive consideration of the value of quality and the cost of quality, which is often a complex problem in itself. The point is, that where quality-control techniques are being applied, the area of speculation is reduced and the necessary considerations can be based on facts.

Recognizing the impossibility of making two or more parts exactly alike, design engineers will provide tolerances for permissible variations. These margins may be set either to facilitate a subsequent mating of parts in assembly operations, or to provide some desired quality objective in the finished product. The engineer's consideration of the magnitude of such tolerances should also include consideration of the tools and facilities which will be used for production, and the type and character of inspections to be employed. However, requirements of this nature, covering tolerances for individual parts, are not sufficient in themselves for the adequate control of product quality. Requirements should also be established for the aggregate quality of a multitude of such parts considered as a whole. Such requirements can be specified in a number of ways, the most common being in terms of permissible per cent defective; al-

[1] "Economic Control of Quality of Manufactured Products," by Walter A. Shewhart, D. Van Nostrand Company, Inc., New York, N. Y., 1931.

Contributed by the Management Division and presented at the Annual Meeting, Atlantic City, N. J., December 1-5, 1947, of The American Society of Mechanical Engineers.

though there are many instances where they can best be specified in terms of the average and distribution.

In this connection, engineers should realize that quantitative requirements which cannot be verified, cannot be relied upon to control quality. For example, conformance to a requirement that a protective finish, such as zinc plating, shall at no point be less than 0.002 in. thick is in itself generally not verifiable. If minimum point thickness is desired, the specification must also indicate the conditions of test under which this requirement may be considered to have been met. Supplementary information is also necessary when a requirement cannot be verified because the specified limits for a characteristic represent destruction, as, for example, in the case of a requirement that a fuse must operate under a load of 3 amp. Proper specification of requirements of this nature necessitates a knowledge of some of the basic principles upon which quality-control techniques are based.

SAMPLING INSPECTION PLANS AND PROCESS AVERAGE PER CENT DEFECTIVE

While quality control is by no means limited to sampling inspections, these operations contribute so largely in the quantitative evaluation of quality that a discussion of some of the engineering considerations involved in planning economic sampling would appear to be justified.

Any sampling plan involves two risks, due to the chance that the selected sample may not contain the same percentage of defective units as the lot from which it was drawn. These risks may be considered broadly as a consumer's risk and a producer's risk. The first represents the chance of accepting a lot at marginal quality, and the latter the chance of rejecting product at process average quality.

When sampling is used for quality protection, the two plans most commonly employed are "lot" quality protection and "average" quality protection.[2] Each involves the selection of random samples from specific lots of product, and the acceptance of a lot when the number of defects observed in the sample is no greater than the "allowable" number, and rejection of the lot when the number of defects observed in the sample exceeds this number. The allowable number of defects is of course based on the probabilities involved.

Determination as to whether or not sampling inspection is economical and feasible and, if it is, which of the many types of sampling plans should be used, must include consideration of the following factors:

1 Are we more interested in limiting the acceptance of more or less isolated lots of product to those lots which contain no more than a specified maximum per cent defective, or in controlling the average per cent defective of a series of lots of product which may later lose their identity in subsequent operations, in stock rooms, or in shipment?

2 What relation exists between the actual per cent defective the process is averaging and the values we wish to use as limiting values, either for individual lot protection or for average outgoing quality protection?

Assuming that we wish to hold the consumer's risk to a constant and reasonable figure, say, .10—which means that if a lot having quality at the marginal value[3] is submitted, it would have only one chance in 10 of passing—we must control the process average per cent defective to a relatively low figure. This is especially so if we also want to keep our producer's risk at a low figure and at the same time enjoy the benefits of small sample sizes. For example, if the process average per cent defective exceeds the limiting value within which we wish to control the average outgoing quality, or exceeds one half the value established as the maximum for any individual lot, sampling is usually not economical. As the process average per cent defective approaches these levels, we can no longer enjoy the benefits of really small sample sizes and still retain a low producer's risk. This means we are forced to spend more money, either in taking larger samples, or in fixing up the greater number of lots that will be rejected, if we hold to a policy of taking small samples under these conditions.

The relationship between the process average per cent defective and over-all inspection effort is very important from a cost standpoint, and both warrant careful engineering analysis. Consideration of these two factors alone may indicate that the cost of refinements in the manufacturing process to reduce the process average per cent defective may be more than offset by savings in over-all inspection effort. Conversely, there may be instances where pressure from inspection organizations has forced uneconomical refinements in processes which cost more to sustain than the resulting savings in inspection costs. The foregoing considerations presuppose a necessary increase in production costs to secure a lower process average per cent defective. Experience has indicated, however, that increases in production costs to improve the quality of product do not necessarily represent a continued burden. In many cases, better control of quality at lower average per cent defective values results in lower over-all production costs. The resultant permissible reductions in inspection effort then represent an added bonus.

Considerations of this character can easily encourage speculation on the advantages of tightening up on the allowable per cent defective as soon as the process average shows evidence of improvement. Such action may result in savings in subsequent assembly operations or in securing a better position in a competitive market, but there are limits beyond which this step-by-step tightening-up procedure will cease to pay dividends. For example, it may be possible, by brute strength and effort, temporarily to reduce the process average per cent defective to a point below the value that can reasonably be expected from the current manufacturing facilities and methods, but if these efforts cannot be sustained, the product will soon show evidences of lack of control, with an accompanying increase in cost. In addition, the arbitrary establishment of stricter quality objectives, each time a production group manages to meet the current bogey, is disheartening and demoralizing. From the opposite point of view, if product remains under statistical control, even around a very low average per cent defective, it may be assumed that there are probably no loose ends in the current production processes.

RELIABILITY OF INSPECTION RESULTS

The successful application of quality-control principles depends upon inspection and inspection results, and our primary concern should be that the inspection results are as reliable as possible, whether they are used for protection or for information purposes.

Here we are faced with a serious problem. The only way we can secure entirely accurate information with respect to any given number of parts or things is to inspect each of them under conditions where there will be no error in measurements or in judgment. The opportunities for operating inspections under such conditions are of course extremely limited. In practice we have indeterminate inaccuracies in the results of almost any 100 per cent inspection or sorting operation due to

[2] "Sampling Inspection Tables," by H. F. Dodge and H. G. Romig, John Wiley and Sons, Inc., New York, N. Y., 1944.

[3] Marginal quality of a lot (lot tolerance per cent defective) is not necessarily the limiting value of usable product but rather is an indication of the quality objective. The chance of accepting a lot having quality poorer than the marginal value is less than the stated consumer's risk.

human error. On the other hand, the results of sampling inspections may not always provide a true indication of quality owing to the laws of chance. Fortunately, however, in sampling inspections, we can calculate the influence of chance, and the effect of the human error is likely to be considerably less because of the interest incentive associated with sampling inspection.

Another and very important factor influencing the reliability of inspection results is the point of view of the inspector. Whenever possible, the inspector should be insulated from exposure to any of the day-by-day problems of production schedules and costs. He should also put himself in the position of the recipient of the product he is inspecting, whether it be the customer or the production group which is going to use the product as a part or subassembly in the next operation. If an inspector allows himself to be influenced, ever so slightly, by a desire to contribute to the output or cost bogeys of a production group because he is "one of the gang," he is likely to look less critically at marginal cases and if, at the end of the week or month, output and cost objectives appear to be in jeopardy, he may also assume that things slightly outside of limits are also marginal and that the shop or production unit should be given the benefit of the doubt. In sampling inspections, where there is an allowable number of defects for a given sample size, these emotions and influences may result in an inspector regarding one over the permissible number of defects as the workings of an unkind fate which threw the extra defect into the particular sample he selected. This can very easily lead to the conviction that had he taken a different sample he would not have found one over the allowable number of defects and it should therefore be disregarded.

Another factor which will tend to influence the reliability of inspection results is the use of favorable gages and measuring devices by inspectors. It is apparent that if the product is averaging close to the limit specified for an individual part, a number of units will pass one gage and fail on another due solely to the differences in gages, even though each gage or measuring device may be within its own permissible tolerance limits. The argument can be advanced, and often is, that if a unit of product meets its specified limits using any appropriate gage, that is itself within tolerance limits, it is good product. The use of favorable gages will of course pass more of this kind of product than an unfavorable gage or even one close to the nominal value. However, the fact remains that when a product is running so close to its specification limits that the question of gage differences arises frequently, the distribution of values is not meeting the design intent, and an analysis of the cause of this shift in average and distribution should be made in an attempt to bring the product back on the beam. The continued use of favorable gages by inspectors will delay warning of this shift in distribution until it has reached a point where unfavorable reactions from recipients of the product may be expected.

The foregoing dissertation on the reliability of inspection results is intended to highlight the effect of the point of view and the influences of emotion on the inspector, rather than honesty or dishonesty. It is important, therefore, to recognize that unconscious inaccuracies can and probably will be present in inspection results if the inspector or his immediate supervision be exposed to the pressures of meeting cost and production schedules. Under such circumstances, it is too much to expect that inspectors can consistently retain the necessary unbiased point of view. This is particularly true where the characteristics are not measurable, since conformance of those judged by eye or feel, such as appearance, general workmanship, degree of smoothness, conformity with color standards, etc., is dependent upon human judgment.

So far we have been concerned with the reliability or lack of reliability of inspection results due to human fallibility. There are, of course, elements of chance inherent in any sampling plan which may also affect the reliability of inspection results. In broad terms and disregarding the human element, these should tend to cancel out over a period of time, provided an honest attempt is made to see that the samples are reasonably representative of the lots from which they are selected.

While, in general, more reliable results can be obtained by increasing the size of samples, a point is soon reached where any further increase in sample size contributes very little. On the other hand, small samples or subsamples taken at frequent intervals definitely contribute more useful information than occasional large samples. The advantages of a series of many small samples as contrasted to a relatively few large samples are twofold: (1) Trends become apparent more rapidly and less material will be produced during the periods while the samples are being inspected and the results analyzed. (2) The small samples permit more ready analysis of the data by subgroups which, in turn, simplifies identification of assignable causes.

The question of representativeness is of particular importance. If we have similar machines or separate groups of operators, each contributing an independent or semi-independent source of production for a single kind or class of product, our samples, to be representative, must include proportionate amounts of product from each of these sources. The selection of samples from a single source must not be allowed to follow any recognized pattern, i.e., they should not be the first 25 or 50 units produced on a work shift, or the last 25 or 50.

The importance of maintaining adequate records of sampling inspections and taking appropriate action when the need for action is indicated cannot be overemphasized. By proper grouping, analyzing, and charting, sampling-inspection results can provide a continuing picture of the level and degree of stability of product quality. This, in turn, provides useful information with respect to the over-all effectiveness of the manufacturing setup.

QUALITY AUDITS

The author's company uses both average-quality and lot-quality protection sampling plans at many stages to control the quality of products bought, manufactured, installed, and repaired. In addition, there is an engineering organization, which is not responsible for costs or schedules, which makes an independent audit of the quality of product after all manufacturing operations, including process and final inspections, have been completed. These audits provide information with respect to general quality levels, and thus the over-all effectiveness of the production setup. They include engineering surveys of production and inspection methods and results, complaint investigations, and sampling inspections based on quality-control techniques. The results are both qualitative and quantitative and provide our management with a picture of quality as our customers would judge it. The principal quantitative results are obtained from inspecting on an hourly, daily, or weekly basis, random samples of several hundreds of general classes of products that are ready for delivery to our customers, and comparing the results with Bell System quality standards—both from the standpoint of conformance with stated requirements and general appearance and good workmanship.

Since the necessary protective features have already been incorporated in process-control inspections and final inspections during the manufacturing processes, these sampling inspections are primarily for informative purposes and are not designed or intended to serve as a screen. However, the inspection procedures include certain quality criteria which become operative

(Continued on page 225)

PREDESIGN RESEARCH *as Applied to* PRODUCT DEVELOPMENT

By ROGER L. NOWLAND

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IN the present day, management and the engineering departments of manufacturing companies are confronted with the necessity of answering the old but greatly intensified question, "What products can I design and manufacture for sale to the market at a profit, and what qualities and characteristics must I build into that product to be sure that it has a profitable market acceptance?" Regardless of the products manufactured or the type of market supplied, the correct answer to that question is the keynote to the success of the undertaking.

Today the engineer has at his command a great mass of technical knowledge, and the ability to apply it to the creation of almost any conceivable product. Facilities to add to this technical knowledge are rapidly being expanded through the construction of new industrially financed research laboratories, expanded university facilities, and increased government and private interest in technical research. The basic questions, therefore, are not where can one get the necessary technical information to develop the product required but what product is required, what product can be manufactured and sold profitably, what product characteristics does the buying public demand. These are the great unknowns facing both management and the engineer, and at the core of all of them is always the buying public. What does it want? What will it buy? What does it need?

THE BUYING PUBLIC OF TODAY

During the last fifty years a rapid evolution has taken place of our industrial economy, resulting from our rapidly expanding technical know-how. The point of view of the buying public has gone through a corresponding evolution as a result of a greater understanding of the basic sciences, a wide experience with manufactured products, and the educational forces of modern advertising. This evolution has brought into existence a discriminating buyer who has established prejudices, definite likes, and a real sense of values. He no longer buys any radio provided it makes a noise, but pays particular attention to the type of noise it makes, how it looks, and to the price that he must pay. The housewife's kitchen sink must not only hold water but it must be attractive looking, easily cleaned, of proper dimensions to serve her requirements; it must be chip-proof, durable, and embody numerous other qualities before she will permit its installation in her kitchen.

These and many obscure factors of market taste and market needs are vital controls over the product of a manufacturing establishment. They must be the guides and signposts by which both management and the engineer direct their product-development work. They are so vital to the success of this work that they can no longer be established by supposition or guesswork as in the past. No manufacturer today can afford to disregard these signposts and assume that by intensive advertising, product prestige, or merchandising trickery he can change them. Money invested in such an attempt is largely wasted and brings little or no return to the stockholder.

The problem, therefore, becomes specifically—how can a manufacturer, or a product engineer, ascertain the character and taste of the market for which he is designing or producing.

A hundred or more years ago, answers to such questions were easily obtained by the artists and tradesmen of those days. Their markets were local and their clientele personally known to them. The idiosyncracies and particular needs of their clientele were directly available to them. The blacksmith of a hundred years ago made a wagon suited to the requirements of the community which he served. Its design and details evolved directly from the farmers' personal instructions to the blacksmith as to what was wanted. The blacksmith applied his creative skill to the construction of the wagon specified by the farmers of his community, heeding their composite and individual needs.

Today, a hundred years later, we find thousands of manufacturing undertakings, producing hundreds of thousands of products, distributed to tens of millions of buyers. The personal touch between the farmer and the blacksmith, the buyer and the producer has been lost in a network of dealers, jobbers, agents, retail outlets, service centers, and what have you. The larger producer of today cannot learn directly from his ultimate customers the shortcomings, the complaints, failures, or inadequacies of the product which he is supplying to the market. Unless this information is available to him, he must of necessity operate on guess and supposition; a most unsatisfactory basis on which to operate a business. Obviously, this is not the answer. The answer is to learn the needs of the buyer. Study, investigate, and evaluate the tastes, expectations, and requirements of the market, and, on the basis of knowledge so acquired, develop the product so as to fulfill the requirements defined.

PLANNING A FIELD PRODUCT RESEARCH STUDY

The process of gathering such facts and tabulating, correlating, and analyzing them constitutes a part of predesign research. The experience which we have had over the last ten years in undertaking predesign research programs for a wide variety of industrial concerns, manufacturing a wide variety of both consumer and industrial products, has established to our satisfaction that this work is a science in itself and one which has been so little practiced that it cannot be controlled by hard and fast rules.

Primarily, it requires a carefully planned program which fully comprehends the market to which the product is to be sold. Then, the defined market must be subjected to a meticulous investigation to ascertain the abstract and hidden factors which make for the acceptance of certain product characteristics and the rejection of others. This investigating work requires that direct personal contact be made with typical buyers and users of the product in question. It is important that the people to be interviewed provide complete coverage of the market in so

Contributed by the Management Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

far as it may vary in its product demands. In some instances the problem might require an extended geographical coverage in others it might require a full coverage of various age groups; and in still other instances, proper coverage may necessitate the selection of certain types of industrial workers. In any case the planning of the program must comprehend properly the particular make-up and peculiarities of the market for the product in question.

In predesign research, the type of interviewing required is considerably different from that involved in other forms of consumer research. In predesign work, it is valueless to depend on simple question-and-answer interviewing. It is essential that all interviews be conducted on a conversational plane, giving free run to the imagination and expression of the respondent. It is important to establish a feeling of confidence and of common purpose with the person being interviewed, in order to overcome any hesitancy to criticize, and allow him to express fully his honest convictions. Interviews of this kind may last from a matter of a few hours to several days—from interviews with one individual at a time to conferences wherein groups of individuals are interviewed simultaneously, permitting individual expression, interchange of ideas, and general discussion so as to bring out any half-formed or uncrystallized ideas, comments, and criticisms.

The extent of the research program required and the number of interviews necessary varies with each problem. In general, it might be said that a particular program has been sufficiently extensive when replies received from further interviews begin to duplicate those replies received in earlier interviews.

Naturally, the field work of any predesign program must be particularly adapted to the problem under investigation. As illustration: To establish the requirements for the redesign of a machine tool as common in its use as the lathe would of necessity involve an extensive program both as to the number of interviews required and the length of each interview. A common electric fan would require a relatively small number of interviews with each interview being of relatively short duration.

ANALYZING PREDESIGN RESEARCH STUDIES

Material collected from predesign field work generally is voluminous and lacks orientation. Since the respondent has been permitted to express himself freely, being guided by the interviewer only as needed to keep the respondent on the subject, the replies collected from the field are generally nonstandard and in jumbled form. Collecting the definite facts from such material is, therefore, a laborious and painstaking job. To orient the material properly preparatory to tabulation, it is first necessary to select from the mass of material the common denominators which define the individual segments into which the respondents have naturally subdivided their thinking. These common denominators then become the focal points about which the various comments, suggestions, and criticisms concentrate. These comments, suggestions, and criticisms can then be tabulated both as to content and frequency to reveal their implications and importance in the minds of the respondents. Direct statistical evaluation of this material is not generally the proper interpretation of the results, however. It is important always to bear in mind that the interview results are in the main expressing the point of view of the respondent and, although all questioning is directed to revealing the reasons for that point of view, it is often true that the reason remains obscure while the point of view predominates. The statistical tabulation and evaluation of the results, therefore, will be overweighed by the respondent's point of view.

To correct such errors, it is important to analyze carefully the results revealed. This analysis must include correlation of the answers obtained from various respondents and their careful study so as to permit supplementation of each point of view expressed by the proper cause or basic reason for that point of view. It is the cause which makes the respondent criticize rather than the fact that he criticizes that is important. The mere statement by a respondent that the speed of a lathe is too slow is a statement of point of view or opinion and, although important in itself, if accepted as a basic fact might automatically lead to the design of faster lathes. However, investigation and analysis of the reason for the statement might reveal that the cutting efficiency of the lathe on certain metals or under certain conditions was low, leading, when properly interpreted, to a completely different change in the design of the lathe, without change in lathe speed.

INDEPENDENT ANALYSIS OF A PRODUCT

Upon completion of the tabulation, interpretation, and analysis of the facts collected from the field, basic information representing field conditions and operations are at hand. On some problems, this information is sufficient to warrant the direct development of design specifications. More generally, however, it is necessary to obtain some basic creative material, independent of this information, which can be combined with the field findings to supply the guiding design specifications. In our experience, this basic creative material can best be obtained by a process which we call "independent analysis" of the product. This work consists of applying an objective point of view to the product and analyzing it in relation to the types of people which constitute the general buyers or users of the product.

By this analytical work, it is possible through a mental, and in some cases an actual, motion study of the product, to ascertain the manner in which the product will be used. Many points of inadequacy and deficiency are thereby revealed. In such an objective analysis, it is necessary to consider the condition under which the product will be used, the physical activities of the user when operating the product, and similar factors. At the outset of this work it is best to disregard, to a large degree, the existing product, as well as questions of manufacturing feasibility, or detailed engineering. These latter points were probably the primary controlling factors in the earlier development of the product and, therefore, were instrumental in forcing it into its present form. Basically, objective analysis should develop ideas and specifications which define the "use requirements" of the device.

PREDESIGN PROCEDURE FOR HOUSEHOLD REFRIGERATOR

The difference between the two types of facts, one obtained from consumer or field investigation and the other from independent objective analysis, can be illustrated by some of the results obtained in a complete predesign study for the development of a household refrigerator.

By means of personal consumer interviews with housewives, conducted by trained individuals, it was possible to get the collective point of view of the housewife on existing refrigerators and certain pertinent facts of a statistical nature.

One of the most interesting of these facts, perhaps, was that a vast majority of housewives interviewed, and they were typical housewives representative of all sections of the country, believed that the ice in the ice trays of the refrigerator was there only for the purpose of keeping the refrigerator cold; they made little or no use of this ice in their normal cooking operations, for cooling beverages, or for any other purpose. This fact was particularly interesting to us, because in the first conference on a new refrigerator-design project, the primary concern of all those present had always been to develop a better and more easily operated ice tray. Here was the point of view

of the male cosmopolitan, not the American housewife; the personal opinion of management, and not of the future buyer.

The designers' and the manufacturers' executive group had had personal experiences with getting ice for their evening highball, but failed to reflect the point of view of the housewife of the average American family. This housewife is concerned with cooking her family's meals and using her refrigerator for the purpose of storing the food utilized in that process.

The housewife's point of view about the ice trays and others of a similar but less dramatic nature, were obtained, as indicated, by a personal door-to-door check with the housewife.

Simultaneously, an independent analysis was undertaken in which the analyst studied the activities of the housewife in preparing a typical day's meals for a typical American family.

In this study, he tabulated occasions on which the refrigerator was used and the purpose for which it was used on each of these occasions. From this study it was learned that the refrigerator door was opened and closed on an average of 44 times a day, and that over 70 per cent of these times was for the purpose of getting milk, butter, eggs, and cream. These are the four products which are the most difficult to store in any refrigerator. Few housewives in their interviews complained about these difficulties, accepting the refrigerator as it was designed as being the only answer possible.

Think for a moment of the prewar refrigerator. The evaporator is located at the top center of the box. The space available for milk bottles, cream bottles, and beverage bottles consists of two narrow shelves, one on either side of the evaporator. Neither shelf is wide enough to take two bottles side by side.

The housewife in her typical use of the refrigerator will probably collect the morning's milk from the back porch and immediately place it on the front of the top shelf. A short time later, she will undertake to prepare breakfast for her family, and, in this process, will require cream for the coffee and cereal. Cream, however, is obtained from the top of the bottle of milk delivered yesterday, which is now at the back of the shelf behind today's milk. She must, of necessity, remove the milk she has just placed in the refrigerator, in order to have access to yesterday's milk, and must then replace the bottles. This process of interchange will go on throughout the day, as she may require fresh milk for the children's lunch or for cooking later in the day. Similar complaints can be made about storage facilities for butter, cream, beverages, and in fact, all facilities provided in the average refrigerator.

The analytical study revealed these and many other defects, some of which were pointed out by a few of the housewives interviewed, but never with sufficient force to warrant their being classified as more than a minor complaint, and certainly never with any indication of practical solution.

The analyst, in the independent objective study of the problem, was free to conceive and did conceive many desired changes in the over-all concept of a refrigerator. Some of these were beyond the realm of practicability for immediate production, but warranted study in later development. Others were improvements which could immediately be incorporated. All, however, were provable improvements over the old type of refrigerator.

It is hoped that the foregoing illustration will make clear the kind of information and the type of facts which can be collected from a field study, and the type of information and facts which can be evolved by the process of independent objective analysis.

CORRELATING ELEMENTS OF PREDESIGN STUDY

When these two parts of the predesign research have been completed, it is necessary to co-ordinate and correlate the findings. In this step, great attention must be given to accuracy and to careful interpretation.

It is first necessary accurately to tabulate and evaluate the findings obtained from the field. The tabulation may be routine, but the interpretation of the findings requires expert judgment and experience. In the interpretation, it is important to give correct emphasis to the several facts collected. This emphasis will be governed by the strength of the opinion indicated in the field study, and by the importance of the particular item as it was revealed in the analysis. Proper correlation of these facts permits a complete and accurate statement of the development problem which must be undertaken.

Specifications developed from these facts are classified as "ideal specifications," in that they have not been modified for engineering practicability, trade practices, industrial trends, or trade standards. All of these factors are important. It is, therefore, necessary at this point to undertake a study of the specifications in terms of production feasibility and cost requirements.

If the possible improvements which are revealed are great enough, and the competitive situation in the trade intense enough, it may be necessary to give considerable thought to improving the production facilities to make the indicated product improvements possible within the cost limits of the trade. Generally, however, such major improvements must evolve over a period of time, with improvements of a more limited nature introduced immediately.

In most cases, the ideal specifications call for modification in view of general trade practices; such as requirements of underwriters' approval, building codes, and the like.

One very important study which must be given to the specifications is their review in terms of general trends. Trends with which we are particularly concerned deal with developments within the industry of a technological nature which may indicate the probable course of competitive products, or trends of an economic nature indicating a change in the buying habits of the public, or in the merchandising policies of the distributor.

The net result of these several modification studies is to superimpose on the ideal specifications certain limitations and confining directives which lead to a restatement of the specifications in final form preparatory to actual engineering design of the problem.

STEPS IN THE EVOLUTION OF A DESIGN

For clarity's sake, it will be well to review the three steps which in our experience are essential in the collection of accurate facts upon which the final statement of the problem can be correctly based:

1 Field product research, which means a study of the problem; evolution of a pattern of questions which will secure the desired information; and a tabulation of this information with interpretation of the pertinent facts revealed.

2 An independent analysis made by qualified people with a completely objective attitude. In this analysis certain statistical facts from the field study may be utilized. However, this work should not be bound by past practice, or practical considerations of cost, or manufacturing limitations. The object of this work is to arrive at ideal requirements regardless of whether or not they can be practically interpreted immediately.

3 Correlation of the facts revealed from the field study with the creative development ideas evolved from the analysis. This correlation results in ideal specifications and recommendations which act as bench marks to guide development engineering and to integrate the requirements of the final design of the product, thereby eliminating much waste of money in undirected development work.

(*Continued on page 225*)

The PRESENT *and* FUTURE *of the* AIRCRAFT INDUSTRY

By CLAUDE N. MONSON

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MEN have found they can fly. Even as Daedelus and Icarus dreamed centuries ago in escaping from the labyrinth, so men dream today of soaring through space. However, the analogy does not end there, for we find that we still may fly too near the sun. In the modern myth, the sun may represent that bright and blinding light of shortsightedness which obscures the vision, and causes us to fall into the sea of apathy. It is the purpose of this paper to suggest the methods by which we may contrive to fly higher and higher, and farther and farther, ever advancing along the path of security and progress.

There has been much speculation in the press about industrial mobilization, about planning for defense, about a unified air co-ordinating committee, and other allied matters. Much of the published speculation is, in fact, already past the blueprint stage, and the aircraft industry is co-operating in making such studies as are requested by the various agencies.

Great emphasis has been placed upon the fact that the industry has been reduced from an annual output of 90,000 to 100,000 planes per year to a current rate of 1500. One seldom sees the statement that the industry was increased from 1000 to 100,000 planes annually. Somewhere between these statements lies an ascertainable fact as to the real requirements of the United States for both commercial and armed-forces purposes. Let us examine these facts:

THE GREATEST NEED IS FOR RESEARCH

No one would sensibly deny that there is a minimum need for development and research into the mysteries of aircraft. No one would deny that we have now reached a new limit in our conception of flight, that of the so-called sonic barrier through which no man has flown and lived. We have found in our laboratories and factories that metals, designs, and construction methods heretofore found adequate, are so no longer, in our efforts to penetrate the unknown areas of more than sonic speed. Friction, shock waves, heat, all combine to make difficult the creation of an aircraft capable of flying faster than sound. To carry on studies made necessary by such problems requires money in large quantities.

The Wright brothers, and others who built their planes of fabric, and wood, and glue, would hardly recognize the modern airplane plant with its dust-free laboratories, its wind tunnels, its specialized machinery, its testing devices—none of which was required in the early days when the height of ambition was just to fly—not high, not far, not fast—just fly! Nor are we content any longer just to fly. We must go farther and faster than ever before. We must continue to lead the world in planes, in speed, and in performance. To do all this takes money. It takes research, design, skill, machines, factories and, above all, trained men to perform those functions.

One does not go forth into the street and say to a man, "I would have an airplane. It shall be the biggest, the fastest, and best in all the world." No, to get such a plane we need, in great quantity, the metal, the parts, and the know-how; the facilities, the equipment, and the skills—in short, men, trained men. We often hear, as airplane manufacturers, the comment that we should not have to cry so loud in the wilderness for money to keep our doors open; that in the event of an emergency we can always build back to a comparable level of plane production achieved during 1944. This is a very important date in retrospect—a date which indicates nearly five years' leeway from the beginning of hostilities in which to prepare.

People say to us, "Your interest in obtaining large sums of money for continued operation is selfish. Why do you preach war and emergency and unrest, and worry us into giving you money for planes we do not now need?"

Let us recall to mind certain facts, widely published but not too widely noted. I quote General Eaker, former Deputy Commander of the Air Forces: "No combat airplane developed after December 8, 1941, appeared in any combat units in the whole course of the war." We must remember that had not Great Britain spent considerable funds in developing the Spitfire and radar before war came, the Battle of Britain might have been lost in 1940. These latter items were the result of years of research; and the radar development of the British was improved and made use of by our armed forces to the great benefit of all.

Then too, people say, "But you must be prepared to do research work and expend monies on development in the normal course of your business. You sell to commercial airlines and surely your profits from that work should be partly set aside for such a purpose." Actually, few if any of our commercial airlines have asked us to develop planes to fly 1000 miles an hour! With no other form of transportation is there the complexity of problems inherent in aircraft. There is no requirement—in fact, there is no room to travel 1000 miles per hour on land. Few people have considered the possibility of traveling 1000 miles an hour on water. Reasoning people will tell us that such land and water speeds would create almost insurmountable problems of friction and motive power. Yet we see daily references in the press—made in sublime faith—that aircraft will soon be built which will fly that fast or faster. Few of those same people realize that the problems of friction are as fundamental in air flow as they are in water or on land.

Aircraft development has now reached the point where we can supply the motive power for high speed, but are lagging behind on construction methods and materials which will withstand the pressures, heat, and corrosive action brought about by such speeds.

AN INCENTIVE TO PEACE

The American people must recognize that the required research program and development of modern aircraft are not paths to war but incentives to peace. From time immemorial the truth of the axiom that the best defense is a good offense, or that in time of peace prepare for war, has been proved. No one ever attacked Rome while the Caesars lived. No one attacked Germany while Hitler prospered. Modern aircraft are

Address presented at the Fall Meeting, Salt Lake City, Utah, Sept. 1–4, 1947, of The American Society of Mechanical Engineers.

prerequisite to national defense; they are essential to competition in international commerce; they are required for the full realization of national growth. We are not pleading for the permanence of our company as opposed to any other aircraft manufacturer, but we do plead for the continuation of a forceful intelligent air policy that will permit of the necessary development program. Any costs inherent in this plan can be measured in lives lost and damage done while America waits for planes not yet built.

When people say to us that a conversion is simple from the field of commercial aviation to that of war, we would remind them that whereas total purchases of commercial planes in any one year are limited to a few hundred, in time of war that figure becomes the daily requirement. No one contemplates converting a freighter to a man-of-war. No one should imagine that a cargo plane may be made into a bomber, nor that a pleasure plane may become a 10-mile-a-minute fighter.

EXPERIENCE WITH THE "FLYING-WING" DESIGN

Let me exemplify the time consumed and problems encountered in the design and development of new-type aircraft by presenting a brief history of our company's experience.

Since the early 1920's Jack Northrop has believed in a flying wing; a plane without conventional fuselage and tail surfaces common to aircraft as we know it today. This conception carried with it the belief that it would be possible to construct an airplane with the now commonly known stressed-skin construction, thus making possible a far stronger and more rigid plane without the requirement of intricate and weight-consuming internal structures. In the year 1929, the first plane approaching this conception was constructed and flown successfully. This design did not have all the factors of stability necessary for the complete elimination of the tail, and it was found necessary to provide this prototype with two outrigger-type booms to carry the necessary tail-control surfaces. A fundamental portion of the idea was achieved, however, in that the engine and crew nacelle were taken into the wing itself.

Lack of development funds made necessary the discontinuance of active development on this project following 1930, for a period of years, during which time many conventional and successful airplanes were designed, built, and flown by Northrop. In 1939 we again began work on the design of a true flying-wing aircraft. This attempt resulted in the successful flight on July 1, 1940, of a flying wing known as the N1M. The date I have just used may be inaccurate, as Tom Ruble, the crew chief on this project, suddenly found, to his great consternation, that he was flying without benefit of wheels during a routine taxi run and engine warm-up. This happened prior to the official flight. This plane was a pusher-type, all-wing, totally enclosed aircraft in which pilot and engine were fully housed inside the wing. All drag surfaces were eliminated so that the surface of the entire plane contributed to its lift. Hundreds of successful flights were made by this model.

Such marked success was achieved in proving this design that the Army Air Forces became interested and sponsored the further development of this type. Even with this encouragement there were many disbelievers in the fundamental design, and, with the inception of hostilities, the company was requested to design various modifications of the basic flying-wing-type plane in order to prove or disapprove the potentials claimed for it by its designer. For this reason experimental contracts were let to build such planes as the XP-56. This plane is a tailless pursuit type, carrying the pilot and engine in a short nacelle. This plane was never placed in production but has been used by the Army for research purposes because of certain other factors of an unusual nature, namely, that it was the first all-magnesium and all-welded plane ever built.

A second departure from the original concept was the development of the XP-79, the so-called Northrop Flying Ram. This is a twin-jet wing-type plane in which the pilot rides prone, as this method of placement increases materially the pilot's ability to overcome the blackout threshold and makes possible more abrupt turns and steeper pullouts from dives.

Still another development of this basic theory was the Northrop-designed jet bomb, the JB1A which was manufactured for the Army Air Forces. This was a pilotless plane which carried nearly 2 tons of bombs within the cast-magnesium center section of the wing, and the ram-jet engine (patterned after the German version) was also enclosed within the wing instead of above the fuselage as in the German V-1 buzz bomb. Current plans in the further adaptation of this plane, because of the greater speeds required, present many new physical problems such as a thin and rigid wing—a perfectly smooth airfoil. The skin is fabricated of sheet magnesium, machined to taper both ways. The skin of the control surfaces is of magnesium plate with the ribbing milled into it for the required strength. Because of the heat generated from the high speeds at which it will be required to operate, it will be necessary to cool the pilot's compartment by refrigeration. The erosion produced by the elements may develop to be one of the greatest problems to combat, in that the material presently used may not withstand the rain and wind blast at these high speeds.

During all this time there was still being built for the Army Air Forces the B-35 flying-wing bomber. In addition to being one of the biggest airplanes ever produced, this flying-wing bomber is by far the most advanced in its design of any large airplane ever built. The B-35 has a span of 172 feet from wing tip to wing tip. The surface of the wing totals 4000 square feet. The length of the wing at the center is $37^1/_2$ feet, and it is more than 7 feet thick at this point. There is a compartment inside the wing for a normal crew of nine persons, and six additional crew members can be carried on special long-range missions. The normal gross weight is about 165,000 pounds and when carrying an overload, in the same manner as most bombers of World War II were operated, the gross weight is 209,000 pounds, or $104^1/_2$ tons.

The crew compartment is supercharged for high-altitude flying, enabling the crew to function efficiently at extremely high altitudes without wearing oxygen masks.

The airplane is expected to have a top speed approaching that of a wartime pursuit, and a cruising range of over 10,000 miles in the overload condition. Its unusual combination of range and speed are directly due to the radical flying-wing design perfected by Jack Northrop.

Even the development of this large bomber has not been conventional, as our company has also been requested by the Army Air Forces to modify two of these planes to jet propulsion. This modification will involve the use of eight jet engines, making it, in so far as it is known, the most powerful bomber in the world today.

While the flying wing was developed strictly as a military bomber, the general arrangement of the plane lends itself excellently to long-range commercial transport use. Estimated costs per ton-mile of operating commercial planes of this type are far below those of conventional aircraft because of the much improved efficiency of the flying-wing design.

APPROACH TO THE FUTURE

In addition to the program outlined, we are currently engaged in developing guided-missile information for the Army Air Forces; a project which must take into consideration both subsonic and supersonic speeds with all the difficulties inherent therein. We are likewise engaged in nuclear-energy research at

(*Continued on page 216*)

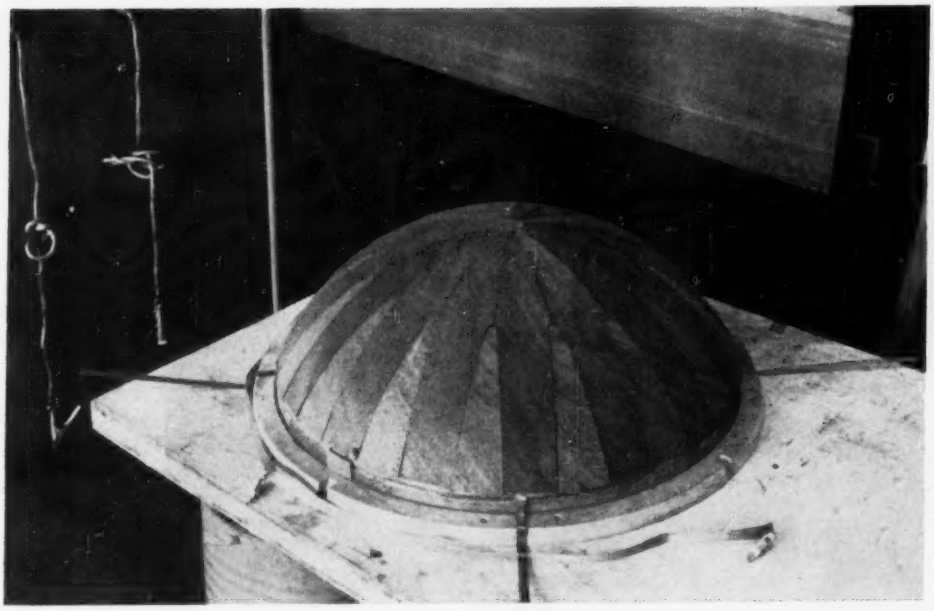

FIG. 1 RADOME OF TAILORED PLY VENEER, MOUNTED ON CERAMIC MOLD WITH ITS METAL-SPRAY COATING TO SERVE AS LOWER OR INTERNAL ELECTRODE FOR HIGH-FREQUENCY HEATING

HIGH-FREQUENCY MOLDING

Method Applied to Compound Curvatures in Wood

By P. H. BILHUBER

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An analysis of the operations, equipment, and cost factors involved in the process or method that has now come to be known by the name of "bag molding" of veneers, such as for instance the Vidal process, employed by Langley Aircraft Company and others for monococque-fuselage manufacture, and by many others for plane parts and boat hulls, led the author in 1943 to the development of a more economical and simplified means of achieving the same results.

The advent of electric heating of dielectric material by means of high frequency, and a fortunate opportunity to attempt to employ this heating means in the experimental manufacture of radomes in wood veneer in semispherical shape with a diameter of 32 in., enabled the author's company to develop a technique which offers significant cost-reduction possibilities in the making of many structures of "compound-curvature" form in wood veneer, cloth, papreg, and the like.

THE "RAYTRONIC" PROCESS

This new process called Raytronic[1] by name, as distinct from the bag-molding and "cooking" method employing an autoclave with steam heat and pressure, consists of the following elements and operations:

Forms. An improvement was first sought in the conventional use of a wood mold or form. Such forms were not only difficult, but almost impossible to reproduce in a multiple number of exact duplicates. There was also no guarantee that any two wood molds which might be identical in shape would remain so with repeated use, due to wear, warpage, and deformation on absorption of moisture.

Therefore a number of ceramic-like male molds were cast from one master metal female pattern or die, in this case in a heavy sheet-metal form firmly braced to withstand distortion which might result from the weight of the ceramic material. Such molds were then coated with copper in a $^{1}/_{64}$-in. film thickness by the well-known Shoup metal-spray process. Adhesion of the coating was excellent.

Coating Serves as Electrode. This metal coating, even though quite thin, constitutes an effective electrode, and serves as one of the pair of electrodes employed in high-frequency heating.

Fitting Veneer to Structure. "Tailoring" the pieces of veneer to fit the required shape of the structure to be made is generally a matter of "layout" on the actual mold itself, and a transfer of the various resultant shapes for the individual pieces of veneer to shaper patterns where, subsequent to rough-sawing on the bandsaw, a multiple number of each piece are simultaneously shaped by machine to the precise outline required. The pieces are then numbered for proper sequence in assembly. The semispherical shape required seemed to provide an opportunity to develop the "pattern" by geometric method in

[1] Raytronic bonding of resin-glued woodwork registered U. S. Patent Office, April, May, and July, 1944.

Contributed by the Wood Industries Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of The American Society of Mechanical Engineers.

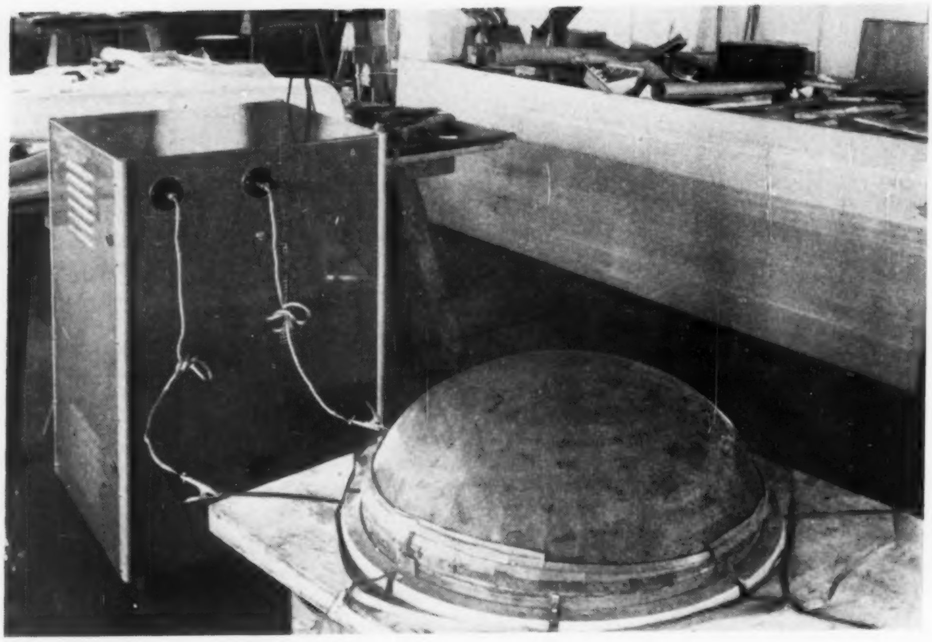

FIG. 2 EXTERNAL ELECTRODE IN PLACE OVER RADOME MOUNTED ON MOLD

(High-frequency device of 1 kw output and leads are shown; mat between external electrode and work is omitted.)

draftsmanship but calculated shapes usually required some initial correction by "cut-and-try" methods.

It is interesting to note that the method adopted and followed was to machine two-ply veneers of $^1/_{48}$ in. thickness each, rather than single thicknesses, anticipating the practice found to be in general use in Germany in aircraft work during the war, so as to prevent splitting and wastage of material.

Glue Gun. In the wood mold-autoclave-bag molding process resort is commonly had to staples or metal tacking of pieces of veneer to the mold in the assembly procedure. No such staples need or can be used in the high-frequency heating method, as the path of the electrostatic field would be channeled through the staples and the veneer structure burned by resultant arcing, quite aside from the fact that it is difficult to drive staples into the ceramic material. Instead of staples, dabs of thermoplastic resin glue are used and placed where needed, then the wood over each dab of glue is heated and cured in seconds of time by means of an ultrahigh-frequency gun especially developed by the Girdler Corporation of Louisville for "tacking" purposes, permitting rapid assembly of the veneers on the mold. A "staggered" build-up of these shaped veneer pieces on the mold accomplishes the overlap of their edges, adding strength to the article to be molded, Fig. 1.

Felt Covering for Veneer. A "tailored" mat of canvas or heavy felt to cover the surface of the veneers upon completion of the assembly serves a double purpose. The small total area and thin wall of the wood radome provides only a light "load" for the high-frequency apparatus employed in the so-called "perpendicular" heating. The mat might be said to increase the load and permit easier "tuning" of the high-frequency

FIG. 3 PRESSURE BAG OF SHAPED OR MOLDED CONSTRUCTION IS INFLATABLE AND LIES BETWEEN MALE AND FEMALE MOLDS OUTSIDE THE ELECTRICAL FIELD EMPLOYED FOR HEATING THE WORK

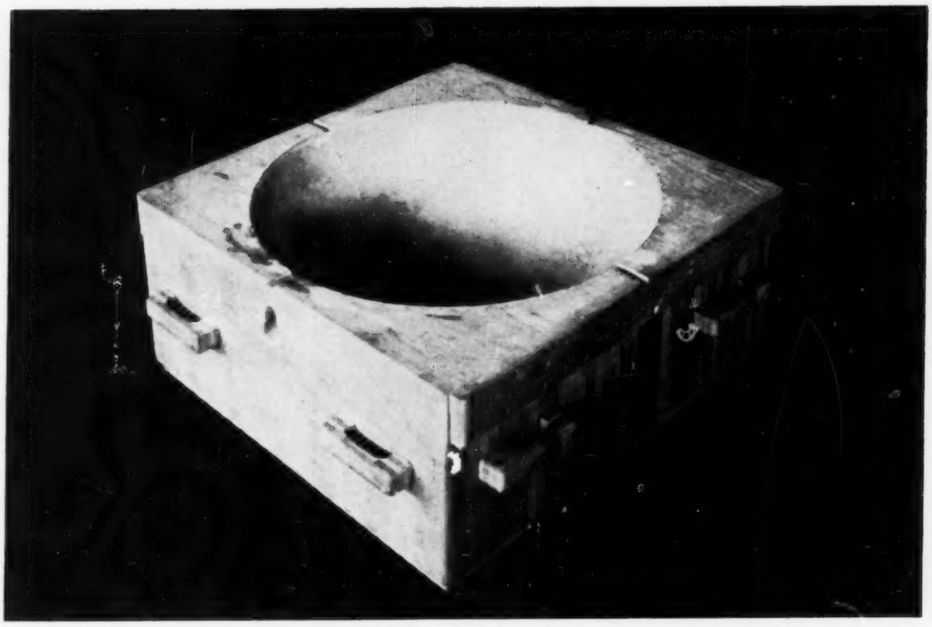

FIG. 4 COUNTERSHAPED "RETAINING" MEMBER OF THE "PRESSURE MEANS" IS THE FEMALE MOLD, LARGER THAN THE MALE MOLD SO AS TO PROVIDE SPACE FOR THE INFLATED BAG, AND "CAPS" THE WORK

(Suitable clamps which are not shown, unite the retaining mold with the plain base under the male mold. The union leaves no aperture for a "blowout." A suitable hole is provided for the valve stem for connection to a compressed-air supply.)

apparatus. It also prevents the imprint, through the pressure applied, of marks or indentation of the second or external electrode.

Second Electrode. This second electrode, conforming in shape to the assembled veneer unit, was fashioned of copper-screen cloth, bound at the edge by a thin sheet-metal strip for attachment to the leads of the high-frequency device. Such "tuning stubs" as might be required by the design of the high-frequency device and the size of the article to be made are also fastened to this strip or to the leads, Fig. 2.

Pressure Method. The pressure means consists of two units, and, unlike the older comparable process, dispenses entirely with the vacuum bag and the steel pressure autoclave. It also reduces the floor space required for the assembly and subsequent cooking operations to the floor dimensions of the mold itself. No heavy mold has to be transported or run into the autoclave on rails or car. Also the unwieldy, expensive, and short-lived rubber vacuum bag, used in the former process to protect the veneer structure from the effects of water and steam in the autoclave cooking, is eliminated as well as the vacuum pump used to exhaust the air from this sort of bag.

In their place, a molded-to-shape rubber inflatable "inner tube" is provided, Fig. 3. The retaining member of the pressure means, usually referred to as a "caul" by woodworkers, is a roughly shaped female counterpart, this time made in wood, of the male mold itself, with an interior dimension which permits a void of some 2 to 3 in. between it and the male mold, Fig. 4. This void is filled subsequently by inflating the inner tube or bag by compressed air, precisely as an auto tire inner tube fills the "shoe." Retaining clamps of any standard make or design are used to couple the female with the male mold before inflation. This apparatus assembly resembles somewhat an auto tire casing and the rim it is mounted on, confining the air to the inner tube, thus supplying pressure on the work. About 50 to 60 psi was ample to secure good bonding.

It will be noted that the inner tube in this instance is applied on the outside of the second electrode, and therefore outside the direct heating field between the electrodes. This fact contributes to the prolonged life of the pressure device, i.e., both bag and the matching molds, whereas through repeated exposure to heat, and folding, creasing, and handling of the bag in the bag-molding process, the life of the latter has been found to be generally restricted to some 40 or 50 bakings, even when using the utmost care. Some heating of a mild nature, it is true, is also found in the inner tube, caused by conduction from the heat generated in the veneer structure itself lying between the electrodes, and possibly from the so-called "stray field" of the electrical device.

It is thought that, barring puncture or abuse, the inner tube will last practically indefinitely, and furthermore that one such "bag" can be used in a production sequence to serve at least three or four molds in turn. Likewise a single pressure-retaining member, or female mold, or mold "counterpart," will serve three or four male molds in turn in actual production operations.

High-Frequency Device. A high-frequency dielectric heating device of 1 kw output capacity, using approximately 600 w, was found sufficiently powerful to heat and cure the cold-setting urea-formaldehyde glue between the layers of veneer in a heating period of 7 to 9 min at a frequency of 8 megacycles and a temperature rise of 100 F above room temperature.

The initial experiment failed in the actual application of heat to the job, owing to the difficulty of "tuning" to the rather small load represented by the two plies of thin two-ply veneers and the thin mat between the electrodes. The addition of tuning stubs and somewhat higher frequency than initially used, and minor changes to the mat, subsequently afforded an opportunity to pump heat into the structure instead of into the leads and the high-frequency device itself. With the heat thus generated, the urea glue used as an adhesive between plies was set and cured, and at the same time, the dabs of thermoplastic glue used in the assembly operation to enable the veneer pieces to remain in position in the "lay-up" operation on the male mold, were softened sufficiently to permit removal of the entire structure from the mold itself, Fig. 5.

WIDER APPLICATIONS POSSIBLE

Successful outcome of the experimental work, and the short operational run employed lead the author to believe that considerable economies in first cost, equipment, maintenance, and floor space can be made by the adoption of this method to much ***larger*** structures of plied or laminated veneers, such as

FIG. 5 COMPLETED RADOME OF WOOD VENEER AND EXTERNAL SHAPED ELECTRODE OF COPPER-SCREEN CLOTH WITH ITS LEADS
(Removal of paper strips, and sanding, and paint finish on outside and inside complete operations on this structure.)

half fuselages and parts for airplanes, boat hulls, furniture, and the like. A clean, cool, and rapid operation results. Moreover, the use of the ceramic mold insures a means of duplication of molds to exact shape in any number which may be required for quantity manufacture.

Another difficulty in the bag molding process, resulting from deformation or distortion of the usual wood mold by warping in the prolonged steam cooking and accidental wetting, is overcome by this dry process. One heating unit, of modest size and current consumption and portable in type, can be employed to service a multiple number of molds. The necessity for live steam at effective pressure levels and the highly dangerous practice of a combination of air pressure and steam pressure are eliminated, spoilage and waste reduced to an absolute minimum, bag repair, and costly replacement dispensed with.

Furthermore, the operation of high-frequency equipment of simplified, modern design now avoids the necessity for engineering talent in its employment. The acquisition costs of such equipment are declining, as simplification in design and competition in price enter this field.

Engineering data can easily be projected for a larger-area structure such as a half fuselage or boat hull in determining power requirements, if the factors of weight, area, time, and type of adhesive for the prospective job are given.

The Present and Future of the Aircraft Industry

(Continued from page 212)

the request of the Government to seek out ways to achieve new power performance for commercial and military aircraft.

All those items are of little concern to private industry as yet. What the future may be, no one knows. We believe that no new knowledge can be brought into being in this world that cannot be useful. We believe that each of the programs now under way at our plant will be of benefit to the nation. We believe that such programs should and must be continued in order that progress be made.

The aircraft industry of today is waging a difficult struggle to maintain its place in industry and to battle all the problems presented by a cutback from some 90,000 planes per year in 1944, to an estimated 1500 planes in 1948. Our problems are many and varied; not the least of these being that of holding the industry together. Of paramount consideration must be the fact that our problems are those of every citizen of the United States. We should not permit the industry to reach too low an ebb. Our national security depends upon it, even as we are dependent upon the contributions made by men and women represented by this Society.

To sustain our industry we cannot manufacture other goods, or our mechanics and engineers become engineers and mechanics in other lines, their technique being lost and their progress retarded. We do not believe consolidation or merger to be the solution to this problem, for in that event the individuality of our engineers is lost, the design development becomes unvaried, and we advance along only one line.

Look in the air today and recognize the handiwork of each individual. Advancing? Yes. But still the hand of the basic designer is recognizable. We in the industry know the home of the plane when we see it. It bears the mark of its creators even as each individual bears resemblance to his progenitors.

Our Government must maintain an adequate research and development program, sufficient to keep the engineers of our industry ever looking forward, overcoming the problems of the air—a production program sufficient to keep hands trained in the technique of producing the engineers' designs, learning new processes, new methods. While this is being accomplished, we will have provided our country with the most up-to-date defensive air force in the world—an insurance policy for national security! We must keep ahead. We have the talent and the will. So long as America needs planes, we and others like us will continve to build them, but it is unreasonable to assume that the aircraft industry can afford to wage the struggle against the unknowns in the field without the complete support of the American people.

NUCLEAR ENGINEERING

Basic Design Background and Scope of a New Branch of Engineering

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INTRODUCTION

ENGINEERS played a prominent role in collaboration with the physicists and the chemists during the war effort to produce the atomic bomb. From this effort has developed a new niche in the many fields of engineering, nuclear engineering. As is true of any new specialization, this field first draws its basic principles from the fundamental sciences and from the older branches of engineering.

Essentially there is little new in nuclear engineering; it is more a redistribution of an engineer's method of thinking and the acquisition of a new set of values and backgrounds. For example, the field of chemical engineering has been defined most advantageously by a group of unit operations such as heat transfer, fluid flow, distillation, evaporation, size separation, etc. To this group, nuclear engineering adds but three new types of operations, shielding, remote control and maintenance, and health safety.

In the first analysis, and paradoxically, nuclear engineering is not particularly concerned with nuclear power. As long as this power has to be obtained through the path of heat, which is the case in the present state of scientific knowledge, there are plenty of engineers well versed in power plants, turbines, and the like, to design the power machinery. Therefore, the duty of the nuclear engineer, in so far as he is a specialist, could end with the method of producing the desired temperature level in a satisfactory heat-transfer medium. He cannot, however, turn over the entire responsibility to power engineers because of the hazards of radioactivity in this field. Shielding, remote control, and waste disposal will always remain in the picture. The nuclear engineer will be more interested in power production itself when and if science evolves methods of releasing nuclear energy usefully by means which do not involve a heat cycle.

Hence the scope of nuclear engineering might be defined as the design, construction, and operation of nuclear reactors to produce power or useful radioisotopes, of radiochemical plants to recover the fuel or the by-products, and of waste storage and disposal systems.

In a research and development sense the field is considerably broader. Knowledge is needed on the effect of radiation on the properties of materials of construction. Special designs of extremely efficient purification processes, heat-transfer media and equipment, pumps, and remote-control devices must be developed and tested. Research is needed to discover better shielding materials. Induced activities in all materials undergoing irradiations need to be studied on a long-term basis.

For most efficient work in this field, engineers must become more familiar with certain phases of physics. Young men who are interested should obtain elementary training in nuclear physics, more training in mathematics, and an understanding of radiochemical techniques. Mechanical engineers should by all means obtain some training in chemistry. Eventually, the nuclear engineer must be able to understand thoroughly the basic physics and chemistry behind the nuclear reactors and the chemical plants he is to build and operate. To develop a strong group of engineers in the field will take considerable time. During the interim period the nuclear engineer must be able to interpret a new set of values to other engineers.

This paper attempts to establish the basic principles of nuclear engineering by presenting some of the new concepts and outlining the magnitude of the design problems. Inasmuch as nuclear engineering is still closely allied to physics and radiochemistry, the presentation will lean toward fundamental principles rather than strict engineering practice.

NUCLEONICS

According to present theory, the atom is made up of a heavy central core called the nucleus, and a cloud of electrons traveling in definite orbits about the core, just as planets revolve about a sun. The central core is about 20,000 times smaller than the volume swept out by the outermost electrons. Therefore the atom consists mostly of empty space.

Most properties and forces associated with the atom as a whole are based upon the electrons. The field of modern chemistry is quite well explained by theories based upon electrons, their orbits, and their interactions.

The first phenomenon to be associated with the nucleus was radioactivity. As information developed, the nucleus was found to be made up of neutrons and protons. By interconversion, loss or gain of these particles, chemical elements can be transmuted one into another according to certain definite patterns.

The nuclear particles, neutrons and protons, are held together by the strongest forces in existence. These are approximately a million times stronger than the electrical forces holding the electrons to the core, which in turn are stronger than the chemical forces holding atoms in molecules. Even these chemical forces are many times stronger than the elastic forces which hold a piece of steel together.

At this point, it is instructive to compare nuclear engineering with chemical engineering. The latter stems from chemistry, as explained in terms of quantum mechanics. Nuclear engineering has its origin in nuclear physics, explained as yet only in part in terms of nuclear-energy levels and other analogies to the more classical explanation of orbital electron behavior. A second comparison of the two fields can be based on the behavior of many particles moving in space, i.e., diffusion. Just as many of the unit operations of chemical engineering are, basically, diffusional phenomena, so are many of the problems in nuclear engineering. Some of these problems are quite complex but a few with which a great deal of design is concerned are less involved than, for example, the design of a multicomponent distillation tower.

NEW CONCEPTS

The magnitude of nuclear energies is the first new concept

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Contributed jointly by the Nuclear Energy Application Committee and the Power Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of The American Society of Mechanical Engineers.

which engineers must grasp. These energies can be evaluated by Einstein's equivalence of mass and energy.

$$E = mc^2$$

where E is energy, m is mass, and c is the velocity of light. The square of the velocity of light is the conversion factor, a truly enormous one equal to 9×10^{20} in cgs units. In engineering terms this equation says that 1 g of mass is equivalent to about 25,000,000 kwhr of energy.

It is impossible to annihilate completely a gram of a given substance. If a gram of uranium atoms, each of atomic mass 238, should split by fission into tin atoms each of atomic mass 119, there is an excess mass remaining which is converted into energy. It amounts to about 0.1 per cent or 25,000 kwhr, still a substantial amount of energy.

While most of the energy appears in the form of heat, a few per cent, still a significant amount, appears as gamma rays and beta particles, giving rise to large amounts of radioactivity. The majority of the heat is dissipated fairly close to its point of origin, but a small percentage appears at fairly distant points and must be removed, generally by secondary cooling media.

Another new concept is the statistical character of work in the field of nuclear physics. This is brought about by the fact that an atom, and, in fact, matter, is made up largely of space. Any nuclear reaction requires that close contact occur between two nuclei. There is always, due to the large spaces and to forces of repulsion, a probability that a reaction will not take place. If both particles entering the reaction are charged, electrical forces make a contact much less likely. Neutrons, having no charge, can make close contact with a nucleus. However, the number of neutrons which can be produced at any one location is relatively small compared to the number of nuclei in a given mass of matter. Thus one deals with individual particles in a statistical manner rather than molar quantities, as in the case of chemical reactions.

Some explanation of terms is necessary at this point. It is customary to describe the probability that a nuclear reaction will occur in terms of the area of the target presented by a given nucleus to an approaching particle. This area is called the "cross section" and is generally expressed in units of 10^{-24} cm^2 per nucleus. A cross section is a specific property of a nucleus and varies widely among elements and isotopes. All nuclear reactions are so described. Thus absorption of a neutron, simple scattering by collision, as well as more complicated reactions, each have a probability of occurrence which is proportional only to a different cross section. Competing reactions to a large extent can be expected to occur in the ratio of their cross sections.

It is convenient to speak of "macroscopic" cross secrion, the cross section per cubic centimeter of a material. This has the dimensions of reciprocal length, so that the reciprocal of the macroscopic cross section is a length equivalent to the mean free path of travel of the bombarding particle between like events.

A third in the new set of values can now be discussed, namely, that the particles of nuclear physics (neutrons, protons, gamma rays, beta rays, alpha particles, and fission fragments) pass relatively freely through the wide open spaces in the atoms of matter. They are not stopped in the same sense as a dam stops a stream of water, but penetrate various distances into a material placed in their path. They are scattered or absorbed according to some cross section. Thus, for example, it may require several inches of lead or many feet of concrete to stop highly energetic gamma rays, and, on the other hand, very thin barriers to stop fission fragments or alpha particles. This disappearance by attenuation is peculiar to the field of nuclear engineering.

A fourth new concept is the restriction placed by nuclear physics on the materials of construction permissible in a nuclear reactor. Owing to the need of neutron economy, it is generally necessary to use materials of low absorption cross section and to use them as sparingly as possible, since the total loss of neutrons is proportional to the macroscopic cross section, i.e., the product of the cross section and the number of nuclei present. This is a restriction which is added to the usual engineering ones determined by strength, corrosion, etc.

This last point generally means that, in nuclear reactors, the heat-transfer medium employed should take up as small a space as possible in the reaction zone. Nuclear reactors are unique in that they refuse to work unless they are designed for a certain critical size. Once this is exceeded they will work almost too well. As a result, the power which can be developed by such a reactor is limited only by the amount which can be removed. The size being fixed within relatively small variations, the surface available for heat removal is similarly limited. This is a situation which usually has not confronted engineers in the past. Ordinarily, surface and temperature difference are the two main variables in heat-transfer problems. In this new application, however, it is necessary to strive for higher and higher heat fluxes and heat-transfer coefficients.

Gilliland[2] has already published a very interesting comparison of the possible cooling fluids for piles, and little more need be mentioned here. Once, however, a given fluid is chosen which is satisfactory from nuclear-physics and stability to radiation requirements, other design variables need to be considered carefully. For example, assuming liquid water as the cooling medium, the heat-transfer coefficient[3] is given by

$$h = 150\,(1 + 0.011t)\,\frac{V^{0.8}}{D^{0.2}}$$

where V is the water velocity fps; D is diameter of the water passage, in.; t is fluid temperature, deg F.; and h is expressed in Btu/(sq ft)(deg F)(hr). For maximum heat transfer, high velocities and small passages are desirable. Both these variables are limited by corrosion and power requirements. Nor is this the end; scale formation, usually generously allowed for in standard engineering practice, where surface is not a limiting factor, may well turn out to be limiting in the long run.

It is not the intention of this paper to consider any of the details of the interesting problems which can be foreseen in heat conduction, heat transfer, and fluid dynamics. Suffice it to state that such problems will be most important in the field of nuclear engineering.

A fifth new concept, is the short time element required in nuclear reactions. A pile can, in the absence of delayed neutrons, increase its power by a factor of e, or 2.7, in times which are extremely short. If, for example, a pile designed to operate at 10,000 kw should get out of control with an excess multiplication constant of 0.10, it will be at a level of 27,000 kw in 0.01 sec. Even with fair safety factors designed into the shielding of, and heat removal in, a pile, it is obvious that little time is available to correct any sudden changes before something serious is apt to happen.

As might be supposed, the main cause of the difficulties in nuclear engineering is the radioactivity associated with this type of work. This is the sixth new concept required of nuclear engineers. One whole phase of the problem deals with the interaction of radioactive particles with materials of con-

[2] "Notes From Seminar in Nuclear Science and Engineering," edited by Clark Goodman, first edition, 1947, mimeographed at the Massachusetts Institute of Technology, Cambridge, Mass., p. 338 ff.

[3] "Heat Transmission," by W. H. McAdams, second edition, McGraw-Hill Book Company, Inc., New York, N. Y., 1942, p. 183.

struction, such as physical properties, heat evolution, etc. Another important phase is the insidious character of radioactivity. It tends to pass through "solid" matter for relatively long distances; it can escape directly through the smallest of apertures; or it can scatter in any direction after a collison. Each radioactive element or isotope, once formed and not subjected to any further bombardment, loses its activity at a very specific rate and nothing known to science can speed or slow that rate. Furthermore, neutrons, after traveling some distance through a material, can induce secondary reactions which may emit high-energy radiations at a point far out in a shield. This second phase generally makes itself felt in estimating and designing shields, waste-disposal systems, and remote-handling procedures, which are problems connected with health hazards during operation, transportation, or storage and disposal after interest in the material has been lost.

Mention should again be made of the cooling fluids at this point. Radioactivity appears in almost any cooling fluid forced through a pile. For example, sodium, oxygen, and other atoms in cooling water, or argon, oxygen, and nitrogen atoms in air can become radioactive. The unique feature of nuclear reactions is the production of radioactivity.

DESIGN ATTACK

In order to point up the effect of this new set of values on engineering practices, a few simple problems will be mentioned, and order-of-magnitude figures given to show the range involved.

Entropy has always been a property of matter which has troubled the engineer. A considerable amount of the difficulty is due to the fact that entropy is associated directly with probability. Inasmuch as probabilities are multiplicative functions, while entropies are additive functions, the relationship between them is expressed as

$$S = k \ln P$$

In nuclear reactions a striking parallelism could be drawn to this function, and the concept of entropy could be used. However, the physicist is very much at home with probability functions, and engineers are becoming much more familiar with statistical mechanics. There is little need for pursuing the analogy further. What is important is that probabilities, expressed as cross sections, enter frequently into all calculations in this field. As a result, logarithmic or exponential functions are very prevalent. In the simpler theories of nuclear physics, many problems are handled through the rate equation

$$dN/dt = \pm N/\lambda$$

which integrates to

$$N/N_0 = e^{\pm t/\lambda}$$

Here λ can generally be taken as a constant if properly chosen, and can be defined as a characteristic length or time.

For example, some of the typical "reactions" which can be handled in an exactly similar manner are listed in Table 1.

N = number of particles at any time or distance
N_0 = number of particles at zero time or distance
nv = neutron flux, product of number of neutrons per cu cm, and velocity of neutrons in cm per sec

The similarity of these reactions suggests that there is a concept, which might be called the law of constant probability, which is quite handy in nuclear engineering. It is the basis for radioactive decay, gamma-ray shielding, and certain neutron reactions. Under a fixed set of conditions, the same probability will always hold. Each nucleus has its own characteristic set of probabilities. If it is an excited nucleus, seeking a lower energy level, it will release energy with a fixed probability each unit of time. Or, a given nucleus has a fixed probability of reaction with a neutron of a certain energy. Again, in regard to gamma-ray shielding, there is effectively a fixed probability of such a ray being absorbed in unit thickness of shield.

TABLE 1 TYPICAL REACTIONS

Type of reaction	Equation	Coefficient
Decay................	$N = N_0 e^{-(1/\lambda)t}$	$1/\lambda$ = mean life, $0.693/T_{1/2}$
Attenuation (shielding)	$N = N_0 e^{-(1/\lambda)x}$	λ = mean free path in substance
Period of pile........	$nv = (nv)_0 e^{\frac{(k-1)}{r_0}t}$	$\frac{k-1}{r_0}$ = effective k divided by neutron lifetime in pile ($\sim 10^{-3}$ sec)

An appreciation of the operation of this law may be obtained from an example. Suppose that one considers 10,000 excited nuclei of the same species having a probability of $^1/_{100}$ of radioactive decay each second. After 1 sec there will be 100 nuclei of a new species and 9900 of the original type. After 2 sec there will be 199 of the new and 9801 of the old species. As time increases, the number of new nuclei added each second is seen to be progressively less. Thus the rate of formation decreases according to the number of original nuclei present.

One interested in the field of nuclear engineering can accomplish a great deal if he learns the vocabulary of nuclear physics, the conversion of less familiar units into more practical ones, and the simple laws of radioactivity and health safety, more or less characterized by the foregoing equations. Table 2 presents a few of the more important units and conversions.

TABLE 2 CONVERSION OF UNITS

1 electron volt (ev) = 1.602×10^{-12} ergs
1 curie = 3.68×10^{10} disintegrations per sec
1 watt = 3.12×10^{10} fissions per sec
1 mass unit = 931.1 million electron volts
0.1 roentgen per 8 hr = 3300 gamma rays (2 Mev) per sq cm per sec
1 watt-sec (joule) = 10^7 ergs
1 calorie = 4.18 watt-sec

A frequently used unit of energy is the electron volt (ev), the kinetic energy of a particle of electronic charge which has fallen through a potential change of 1 volt.

The definition of the curie has changed during its history. Different texts will give different definitions. One curie is approximately equivalent to the activity of 1 g of radium in equilibrium with its decay products. For the purposes of this paper, 1 curie is taken as the activity of 1 g of radium.

Radiochemical techniques are sensitive enough to permit working with as low as 50 disintegrations per min. Hence about 10^{-11} g of radium is sufficient. Radium has a half life of 1590 years, and a molecular weight of 226. For the lanthanum isotope, a fission product, with a half life of 40 hr and a molecular weight of 140, 1 g is equivalent to 5.6×10^5 curies, about $^1/_2$ ton of radium. Something like 10^{-16} g is easily detected. The order of magnitude of these figures is the result of the large conversion factor between mass and energy.

The health hazards involved are of immediate concern. Considering only the external effect of exposure, 1 g of radium in equilibrium with its decay products, produces a dose of 5 roentgens per 8 hr (5 r/8 hr) at 1 meter. Tolerance for continuous daily exposure has been set at 0.1 r/8 hr. A roentgen is that quantity of x-ray or gamma radiation producing in air

one esu of charge in 1 cu cm of air under standard temperature and pressure. A tolerance dose is equivalent to 16 μw hr of gamma radiation per day received by a man weighing 150 lb. As a matter of comparison, a person sunbathing receives energy at the rate of 100 w at noon, and a chest x ray gives a dose of 1 roentgen.

The lanthanum isotope previously mentioned is much more potent. It has a high-energy gamma ray of 2.3 Mev. One gram would give a stupendous dose of about 5×10^6 r/8 hr at 1 m.

Such doses lead immediately to the question of shielding. Nuclear particles vary widely in their penetration of matter. Alpha particles are stopped completely by 1 in. of air, 0.001 in. of aluminium, or 0.001 in. of lead; beta particles of 2 Mev energy by 23 ft of air, or $^1/_8$ in. of aluminum; gamma rays of 2 Mev energy are reduced by a factor of 10 in 1300 ft of air, 20 in. of water, 10 in. of concrete, 8 in. of aluminum or 1.7 in.of lead.

For shielding against gamma rays, which is the most usual requirement, the coefficients to be substituted in the second equation given in Table 1 are listed in Table 3. Here the coefficient is the reciprocal of the mean free path. This table is calculated from Heitler's text.[4]

TABLE 3 GAMMA-RAY ABSORPTION COEFFICIENTS, μ cm^{-1}

Mev	Air	H_2O	Concrete[b]	Iron	Lead
0.25	1.40f[a]	0.124	...	0.95	5.0
0.5	1.11f	0.095	...	0.63	1.7
1.0	0.8f	0.069	...	0.46	0.8
2.0	0.56f	0.048	0.11	0.32	0.5
2.5	0.50f	0.043	0.099	0.31	0.47
5.0	0.35f	0.030	0.069	0.25	0.48

[a] $f = 10^{-4}$
[b] Density = 2.3 g per cc.

This table says that the intensity is reduced by a factor of $e^{-\mu}$ for each centimeter of the material placed in the path of the gamma radiation. In addition to reduction due to the material of a shield, there is a reduction due to distance from a point source of radiation. This reduction factor results from the fact that the radiation spreads out uniformly in all directions. It is equal to $1/4\pi a^2$ where a is the distance in centimeters from the source.

To reduce the dose received from 1 g of lanthanum, which is 6.3×10^{11} r/8 hr as a point source to the daily tolerance of 0.1 r/8 hr at the surface of a shield, requires a reduction factor of 6.3×10^{12}. For a 2.3 Mev gamma ray, μ for lead is about 0.47. Assuming a priori that the shield will be 41 cm thick, the reduction factor due to distance is 2.1×10^4, leaving 3×10^8 to be handled by the lead. The thickness is obtained from

$$3 \times 10^8 = e^{-0.47x}$$

About 41 cm is required. In the form of a sphere this amounts to 3.6 tons of lead.

Another important problem of nuclear engineering is the disposal of wastes. From radiochemical plants designed to recover uranium or plutonium, an enormous number of beta and gamma curies of activity associated with the fission products must be disposed of. For health safety and, in order not to pollute streams, the simplest procedure is to store the wastes properly shielded for very long periods of time.

An appreciation of this problem is obtained when it is realized that even after a nuclear reactor is shut down and fission is no longer occurring, both heat energy and radiation continue to be produced for a long time as the various fission products decay with their characteristic half lives. The initial reduction factor at shutdown is manyfold. It then falls off logarithmically, although not strictly according to any simple equation. Even after 5 years, the reduction factor is less than 100,000 fold. These seem like large numbers but one is dealing with the order of magnitude of millions of curies of radioactivity during operation. For some time after operation, sufficient heat is developed to require continued although reduced cooling. When it is realized that tolerances for health are of the order of 0.01 curie, it is obvious that the need for careful control and shielding still exists after five years.

Along this same line, induced activities in any pile coolant must be examined. For example, if cooling water containing several ppm of sodium ion is exposed to neutron fields, sodium 24 is formed. This isotope has a half life of 14.7 hr and emits a 2.8-Mev gamma ray. Radioactive tolerance for 24-hr submergence is about 0.5 microcurie per liter for gamma emitters. Activities from this source alone in the water can be severalfold higher than this tolerance level. Since the level of activity is reduced twofold every 14.7 hr, the water may have to be stored temporarily before discharge into a river.

None of the problems of nuclear engineering is as simple as the illustrations given here imply. This is due to the fact that one is dealing with mixtures of many radioisotopes. Also, there are parent-daughter relationships and whole chains of decay products formed from the original fission products. However, such complications do not alter the basic principles brought out by these examples.

While emphasis in this paper has been placed on nuclear reactors rather than on radiochemical plants, the same general problems of shielding and health safety exist. They are much simpler, since neutrons do not enter the picture. Remote control and maintenance are somewhat more important, since moving streams of liquids and solids must be handled from vessel to vessel. Waste disposal is an important problem since most of the waste occurs only after chemical processing. The basic difference between radiochemical and chemical plants processwise is the necessity of separating, recovering, and purifying traces of elements. One is generally attempting to work with grams of an element mixed with equal amounts of impurities, and, in a total mass of uranium, for example, of 1 ton (10^6 g). On the other hand, high efficiencies for recovery of the product and of the uranium are required, primarily because of the small amount of the product present, and ultimately because of the value of the product and the uranium.

CONCLUSIONS

Nuclear engineering will be an important field of specialization in the future. It requires a more intimate knowledge of physics and chemistry than the majority of mechanical engineers receive in colleges at the present time. An engineer working in this field needs a reorientation in the order of magnitude of his thinking and a clear visualization of concepts which in the past have not been necessary. For some time to come, he will have to depend in large measure upon the physicist and mathematician.

The unique features of the field are primarily the result of radioactivity phenomenon which in turn is closely related to nuclear physics. Shielding, lack of accessibility for maintenance, health hazards, and waste disposal are several of the important features requiring considerable design ability.

This new field is recommended as one of the most challenging and fascinating which has developed in the past two decades.

[4] "Quantum Theory of Radiation," by W. Heitler, second edition, Oxford University Press, 1944, New York, N. Y., p. 215.

CONDENSATION NUCLEI

Their Significance in Atmospheric Pollution

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INTRODUCTION

In our everyday life, visual perception plays perhaps a more important role than any of the other senses with which we are equipped by nature. It is therefore quite understandable that the average person associates with the term "atmospheric pollution," clouds of dust, palls of smoke, or deposits of soot, phenomena which are so familiar to the residents of industrial cities. On the other hand, "air" is usually considered the prototype of the invisible, of the intangible, and any suspensions in the air which do not conform to this concept are regarded as foreign to the atmosphere and thus as "pollution." According to Webster, the term pollution implies uncleanness, impurity, in short, something undesirable.

Although the scientist often accepts popular concepts, he is generally inclined to suspect that apparently "obvious" phenomena imply, literally, "more than meets the eye." To show that this suspicion is also justified with regard to atmospheric pollution is the objective of this discussion. It will be shown that what seems foreign to the air at first sight is by nature an integral part of it and that the more important aspects of pollution generally escape attention.

THE ATMOSPHERIC CONSTITUENTS

We can distinguish two classes of atmospheric constituents: namely, the permanent gases, chiefly nitrogen, oxygen, traces of argon, neon, etc.; and the variable constituents which include water in its different states, carbon dioxide, ozone, and various suspensions, either in gaseous, liquid, or solid form. These suspensions, known by the collective term "aerosol" (20),[1] will be considered in detail.

Dust. There are two general types of aerosols. The first type is represented by the so-called "neutral" particles (3), commonly known as dust and experienced by everyone, as it is the more conspicuous type of suspension. It often represents a special problem to the mining engineer, the mechanical engineer, the industrial engineer, and many other professional men. Dust consists of finely divided solids derived from weathering, drilling, handling, and preparation of rocks and coal. Dust may also consist of organic or inorganic particles resulting from manufacture of a variety of products such as flour, rubber, lime, and steel, from traffic on land be it on the highways, on rails or in city streets, from decomposed vegetation or from volcanic eruptions. Perhaps the most reviled member of this class of suspensions is the soot and fly ashes from coal fires and other combustion processes.

The cosmic source of dust, namely, the injection of meteoric matter into the atmosphere, is of minor significance, because the concentration of particles is exceedingly small despite the relatively large mass of material which invades the earth's atmosphere from space.

In general it can be stated that the atmosphere would contain dust even in the absence of the sources occasioned by human activities, because the chief sources of dust are natural ones (4), such as volcanic eruptions and, particularly, dust storms originating in desert areas. It has been estimated that the volume of fine ashes thrown into the atmosphere by a strong volcanic eruption amounts to as much as 100 billion cubic yards (4). As another example of Nature's prolific dust sources, the single dustfall of March, 1901 (9), may be cited, when about 2,000,000 tons of dust from the African desert were deposited over Europe alone, not counting what remained in suspension and drifted with the air currents beyond the limits of the continent, or what was deposited over the Mediterranean Sea and elsewhere In February, 1903, nearly 10,000,000 tons of red dust from northwest Africa were deposited over England (19).

The size of the neutral dust particles ranges from about 3×10^{-5} to 10^{-3} cm and larger (8), i.e., from microscopic diameters to kernels visible to the naked eye. The median and modal size for large American cities was determined at about 5×10^{-5} cm (10). It is not astonishing that it is particularly the large dust particles which arouse the ire of the housewife and other people concerned with the nuisance of dust. However, it should be noted that the large particles are in general rather short-lived as suspensions because they settle quite rapidly out of the air near their source, and once they are deposited, they cannot properly be called suspensions any longer, even though they may remain a nuisance.

Condensation Nuclei. Another type of suspension which is far more important than the neutral dust, is the "active" dust (16) which is made up of hygroscopic substances. Due to their affinity for water, the hygroscopic particles play an all-important role in the transformation of water vapor into liquid water droplets or solid ice particles. When the moisture content of air which is devoid of any suspensions, is increased to and above the saturation point, spontaneous condensation into water droplets will not occur until a supersaturation of roughly 800 per cent is reached (15). The fact that water vapor ordinarily requires some surfaces on which to condense under conditions of saturation or only slight supersaturation, is easily observed when drawing hot water in a bathroom. A deposit of dew droplets on walls, mirrors, windows, etc., can usually be seen before a steam cloud will form throughout the room, if indeed it forms at all. In the free atmosphere the hygroscopic suspensions furnish the surfaces necessary for the process of condensation, and therefore these particles are called "condensation nuclei." As such, they are of vital importance in the formation of fog, clouds, and eventually, rain. The significance of rain in the maintenance of organic life on this earth is too well known to require further discussion.

CHEMICAL NATURE OF CONDENSATION NUCLEI

There is a great variety of substances which serve as nuclei due to their hygroscopicity. Chloride salts and sulphuric acid are perhaps the most important chemicals in the air acting as nuclei (1, 3, 15). Other nuclei-forming substances are phos-

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Presented at a Joint Fuels Conference of the American Institute of Mining and Metallurgical Engineers and The American Society of Mechanical Engineers, Cincinnati, Ohio, Oct. 20–22, 1947.

phorous compounds, oxides of nitrogen, and nitrous acid which may form from the nitrogen, oxygen, and water vapor in the air either in the presence of ozone (2, 18), by lightning (18), or by contact with glowing metal surfaces (5). The importance of combustion processes for the production of nitrous acid was stressed by Coste and Wright (5).

The importance of sulphur as a nuclei-producing agent was clearly shown by Ives and collaborators (10), who demonstrated the parallelism of the sulphur content of air and the number of condensation nuclei, Table 1, in several American cities.

TABLE 1 SULPHUR CONTENT OF AIR AND AVERAGE NUMBER OF NUCLEI IN REPRESENTATIVE CITIES

Sulphur, μg per m^3	Nuclei per cu mm
0–50	150
51–100	217
101–150	231
>150	316

The specific role of sulphur dioxide in the production of nuclei was investigated by Aitken (1). He reasoned, and demonstrated by experiment, that sulphur dioxide under the influence of ultraviolet radiation is oxidized to the highly hygroscopic sulphur trioxide, which, together with water vapor attracted from the air, forms minute droplets of sulphuric acid. He thus explained the frequently observable fact that in industrial areas a thin haze or smoke layer will often turn into a dense fog when the morning sun shines on it. However, a direct correlation between the intensity of the ultraviolet portion of sunlight and the number of nuclei at ground level is difficult to establish, because the ultraviolet radiation is not only affected by the property of the air layers at greater altitudes, but is also depleted by the nuclei themselves. Both effects were shown by Ives and Gill (11) who found that, under clear skies (with strong ultraviolet radiation), the nuclei content was somewhat higher than under cloudy skies. On the other hand, they also demonstrated that more intense ultraviolet radiation was associated with a smaller nuclei content of the air, as is evident from Table 2, reproduced from the paper cited.

TABLE 2 AVERAGE ULTRAVIOLET[a] RADIATION AND NUMBER OF CONDENSATION NUCLEI[b] FOR CLEAR SKIES

Sky condition	Most smoky cities UV	Most smoky cities N	Least smoky cities UV	Least smoky cities N
Clear	24.2	240	36.4	172
Cloudy	8.1	207	16.9	162

[a] UV in microwatts per sq cm.
[b] N per cu mm.

This latter effect was also confirmed by H. Landsberg (14) at State College, Pa., a place remote from industrial activities, where a definite decrease of the biologically effective ultraviolet light was observed with an increase in number of condensation nuclei. That the observed effects are a function of the chemical nature of the nuclei involved can be deduced from the fact that on the Island of Sylt in the North Sea, the author (17) could observe the same effect of sky condition (as that shown in Table 2) only when the wind blew from the near-by mainland, while the reverse was true for a wind from the sea, as shown in Table 3.

The winds from the land, aside from their higher nuclei content, apparently carry substances (most likely sulphur dioxide) from combustion processes which become nucleogenic under the influence of sunlight, whereas the nuclei in winds from the sea consist chiefly of chlorides and other ocean salts

TABLE 3 AVERAGE NUMBER OF CONDENSATION NUCLEI PER CUBIC MILLIMETER FOR CLEAR AND CLOUDY SKIES

Sky condition	—Wind blowing from— Land	Sea
Clear	3.4	1.1
Cloudy	3.0	1.2

which are hygroscopic without a chemical transformation due to sunlight.

The transformation of sulphur dioxide to sulphur trioxide may also be caused by the presence of other oxidizing agents in the air, such as nitrous acid (5).

It may be mentioned that when the atmosphere is greatly supersaturated with water vapor, a condition which is rarely, if ever, found in nature, nonhygroscopic particles of very small size (12) may also act as nuclei. Similarly, positively or negatively charged ions will serve as nuclei in highly supersaturated air (15). Such ions may be produced by radioactive material, cosmic rays, lightning, x rays, ultraviolet radiation, etc. (12).

THE SOURCES OF NUCLEI

The chief natural sources of nuclei are volcanic eruptions, spray from ocean surfaces (16), combustion products from forest and steppe fires (4), swamp gases, exhalations from living or decaying vegetation, and bacteria. Man-made sources can be enumerated as follows: Industrial furnaces and processes of various kinds, such as blast furnaces, Bessemer converters, rolling mills, coke ovens, in short, all industrial chimneys. Our modern transportation facilities, such as steam and Diesel locomotives and boats, automobiles, and airplanes, are also copious producers of nuclei. Domestic sources are oil-, gas-, or coal-fired furnaces, cooking stoves, incinerators, and tobacco smoke. In other words, nuclei are produced wherever substances or processes give off odoriferous fumes (2, 16), where materials are glowing hot, or combustion takes place, whether visible smoke is emitted or not. Again, as in the case of dust, man-made sources are insigificant by comparison with natural sources (4).

It may be in order to quote some numerical values in order to illustrate the variation in the nuclei content of air as well as the effectiveness of various sources.

An average grass fire extending over 1 acre, produces some 20,000 billion-billion ($= 2 \times 10^{22}$) nuclei. If these nuclei were distributed through a column of air having a cross section of 1 acre and a height of 10,000 ft, there would still be a concentration of roughly 2 billion particles per cu cm. One puff of cigarette smoke contains some 4 billion nuclei according to Aitken.[2] Melander (16) found that the number of nuclei increased from about 2600 to 35,000 per cu cm when the wind carried the smoke column of Mount Vesuvius over the place of observation at a distance of 6 miles. Measurements of J. H. Coste and H. L. Wright (5) showed that a flame of commercial coal gas lit for only 15 sec increased the number of nuclei in a chamber from 109,000 to 860,000 per cu cm. These authors also showed that the greater the sulphur content of the fuel, the more nuclei are produced by its combustion. Junge (12) computed that a flame of commercial coal gas which consumes 0.43 cu cm of gas per sec and contains only 0.003 per cent sulphur dioxide, derived from combustion of 0.073 mg of carbon disulphide in that volume, produces every second 250 billion ($= 2.5 \times 10^{11}$) sulphuric-acid particles of 7.5×10^{-7} cm radius. Salles[2] measured in the streets of Paris 40,000 nuclei per cu cm, which number increased to more than 100,000 when an automobile passed near by. Amelung and Landsberg (2) found in a ventilated kitchen with a large gas range in use, the number of

[2] Quoted from Landsberg (15).

nuclei exceeding 500,000 per cu cm, while the outside air contained only about 25,000 nuclei per cu cm.

PHYSICAL PROPERTIES OF NUCLEI

As regards the size of the nuclei, they are for average humidity conditions, of the order of 5×10^{-6} cm (3, 5) and range from about 10^{-7} to 10^{-5} cm radius (15). Their weight has been estimated at 10^{-14} to 10^{-18} g or an equivalent of an aggregate of 10^6 molecules. The minuteness of these nuclei is perhaps more comprehensively illustrated by the fact that 100,000 nuclei of spherical shape fill a volume of only about 5×10^{-11} cu cm, or that it takes 2 million billion to occupy the space of 1 cu cm. Thus it is evident that, ordinarily, the nuclei are invisible. However, since their size is a function of the moisture content of the air, due to their hygroscopic nature, their presence may become apparent indirectly as haze, or as fog or cloud droplets,[3] under the proper moisture conditions. Experimental studies by Junge (12), in good agreement with the theoretical analysis by H. Köhler (13) revealed that the size of the condensation nuclei is practically unaffected by the humidity in the air as long as the relative humidity remains below 70 per cent. Under this condition, the nuclei are either solid, liquid, or gaseous particles, depending on their chemical composition. When the relative humidity increases above 70 per cent, these particles grow slowly at first and then rapidly as the relative humidity approaches 100 per cent. This is shown in Fig. 1 by the solid curve.

For comparison, the average visual range in miles was computed as a function of relative humidity from the material obtained by the author (17) on the Island of Sylt, and plotted as a dashed curve in Fig. 1. Since, at the location mentioned, the

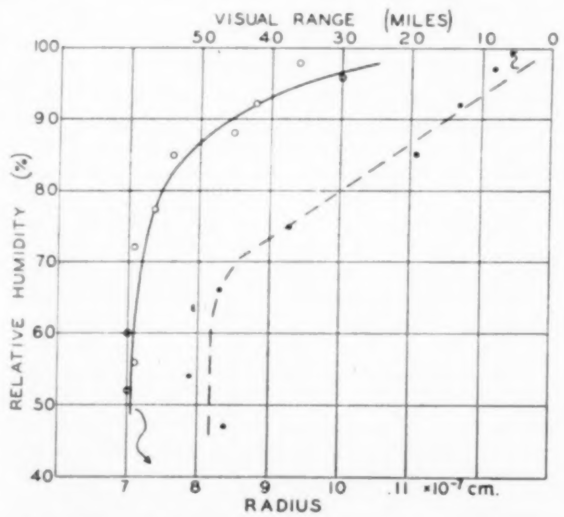

FIG. 1 RADIUS OF A CONDENSATION NUCLEUS AND AVERAGE VISUAL RANGE AS A FUNCTION OF RELATIVE HUMIDITY (12)

nuclear climate with respect to number and type is fairly uniform, it is to be expected that the visual range decreases with increase in size of the nuclei because the amount of veiling light scattered by the nuclei is a function of their size. This is well brought out by the portion of the dashed curve above 70 per cent relative humidity.

In general, the absorption of water vapor from the air by the nuclei at relative humidities above 70 per cent transforms the nuclei from gaseous, liquid, or solid particles into tiny droplets of salt or acid solutions whose concentration varies with the original size of each nucleus and the amount of water absorbed. In turn, the amount of water condensed on the particle is a function of this concentration and the size of the particle. In addition, the presence of electrical charges on the nucleus has an influence on its hygroscopicity or, more precisely, on its vapor pressure. The various effects of the properties of nuclei on the condensation process can be summarized as follows: Water vapor will condense more readily on a nucleus the greater its concentration of salts or acids, the greater its electrical charge, and the greater its radius. Thus (neglecting the small effect of electrical charges) during the process of condensation, the growth of the smaller nuclei is slower than that of the larger ones, so that even dense fogs or clouds in relatively pure air contain a large number of free nuclei (15) which have not grown to the size of fog or cloud droplets, i.e., to a size of the order of roughly 10^{-3} cm (3). Only about 300 to 500 nuclei per cu cm are needed for the formation of dense clouds (15).

Fig. 1 also shows quite strikingly that condensation is a continuous process which, in effect, begins at humidities far below the saturation point as determined for plane pure-water surfaces. Therefore the decrease in transparency of the air with increase in humidity is also continuous, and the transition from clear air to haze to fog is so gradual that it is impossible to determine the instant at which the haze stops and the fog begins.

The visibility and stability of the condensation products, among other factors, is dependent upon the size and the number of droplets. In industrial regions with their overabundance of nuclei, the transparency of the air is markedly reduced, when the relative humidity has not yet reached 100 per cent. By contrast, in relatively pure country air, saturation may exist for some time before the fog becomes visible. Nevertheless, the meteorological conditions which lead to the saturation of the air near the ground, usually affects regions on such a large scale that the frequency of foggy days cannot readily be taken as an index of air pollution. This is evident from the fact that the average annual number of days with dense fogs for the period 1936–1940 inclusive, is 12 at Cincinnati, Ohio, 11 at St. Louis, Mo., and 13 at State College, Pa. This means that the frequency of dense fog is practically identical at all three localities. However, if records of the duration of fogs were available for comparison, it is almost certain that the number of hours with dense fog would be smallest at State College.

COMPARISON BETWEEN THE TWO TYPES OF AEROSOL

Aside from the all-important role that nuclei play in the atmospheric-condensation processes, they also surpass dust in point of number, greater persistence as an aerosol, and their chemical and, possibly, biological action.

As regards the concentration of particles in a unit volume of fairly clean air, the nuclei are about 50 times as numerous as the dust particles; for example, Giner and Hess (8) found in Innsbruck, Austria, the mean annual number of nuclei to be 24,100 per cu cm, the number of nonhygroscopic dust particles to be 464 per cu cm. In industrial cities (10), the dust particles represent only a fraction of 1 per cent of the total amount of

TABLE 4 MEAN NUMBER OF CONDENSATION NUCLEI[a] FOR VARIOUS RANGES OF DUST CONCENTRATION IN CITY AIR (AFTER IVES AND COLLABORATORS)

D per cu cm	N per cu cm
<500	189000
500–999	211000
>999	223000

[a] N = mean number of condensation nuclei.
D = dust concentration.

[3] The fact that a fairly large droplet condenses around each nucleus under condition of saturation or slight supersaturation, is utilized in the method of counting the number of nuclei in a "cloud chamber."

suspensions found in the air, as can be seen from Table 4. This table also shows that a certain parallelism exists between the concentration of dust and that of nuclei. This is not surprising since both types of aerosol are produced as a result of the same human activities (10, 15). A pronounced parallelism can also be found with respect to diurnal and annual variations of the atmospheric dust and nuclei content (8).

In the free atmosphere, the nuclei exceed the dust particles by a factor of several thousand (6). This is chiefly due to the fact that the dust, by virtue of its larger particles, is subject to considerable sedimentation (20), while the smaller nuclei are easily carried to higher altitudes by light convection currents (6, 8). Measurements made in free-balloon ascents (6), showed for the first 2000 meters, an increase of about 25 per cent in the ratio of number of nuclei to that of dust particles. Nevertheless, the nuclei content decreases with increase in altitude above the surface, even though at a slower rate than does the dust content (6, 8, 15). This decrease is due to dispersion and coagulation (12).

Similarly, the horizontal transport by wind generally carries nuclei to greater distances from their source than dust particles. The fact that salt nuclei from the oceans are found in the middle of large continents, illustrates the ease with which these small suspensions ride the air currents. The previously mentioned cases in which dust from desert areas travels over great distances, depend on special meteorological conditions, which are the exceptions rather than the rule. At any rate, dust from industrial sources is usually deposited within a relatively confined area around the source, whereas the simultaneously produced nuclei are often carried far to the leeward.

As far as the cleansing effect of rain or of other forms of precipitation on the aerosol is concerned, it seems logical to assume that the large dust particles are more easily "washed" out of the air than the small nuclei. However, the results of pertinent investigations by various authors are by no means in agreement. For instance, according to the findings of Giner and Hess (8) at Innsbruck, rain lowers the number of nuclei "as a rule," while the dust content is "always" diminished. By contrast, Ives and collaborators (10) could not detect any effect even o heavy rain on the dust content of the air in American industrial cities. It is not possible at this time to decide whether this discrepancy is due to the difference in the aerosol climate between the localities cited, or whether it is due to the difference in methods employed for the dust determinations.

Similarly, inconsistent results become apparent when investigating the effect of precipitation on the number of nuclei. Not only does the nuclei content often not diminish during or after rain, but also in many instances, a pronounced increase can be observed (15, 17). The nucleogenic property of rain, particularly of the shower type, is most likely attributable to the production of ions by the splashing of rain droplets, the so-called Lenard-effect (15).

Probably the most obvious physicochemical effect of the aerosol is the corrosion of exposed surfaces caused by the chlorine, sulphur, and ammonia compounds of which the nuclei consist. Manifestations of this corrosion can be observed on house façades (4) in all industrial regions with their abundance of sulphuric-acid suspensions, or at the seashore, where the relatively high salt content of the air often proves destructive of inadequately protected mechanical devices, such as camera shutters and watches. Notwithstanding the undesirable chemical properties of nuclei, they have also beneficial aspects. The bracing effect of the salty ocean air, for example, is well known to the vacationist. Also the sulphur content of the air is becoming an increasingly important natural source for this element, an essential item in soil fertility (7).

Dust likewise has its dual aspects, which become immediately apparent when one considers, for example, the "dust bowl" of the United States and the fertile loess deposits in eastern Asia. The dust from combustion processes and traffic found in city air, is, for the most part, a public nuisance. However, most of the substances of which this dust is composed, such as carbon, fly ashes, and minerals, are chemically too inert, and the large particles which might cause erosion of surfaces are too few to equal the importance of nuclei in the problem of air pollution. The tarry components of dust have probably a deleterious effect on plant life. However, even this growth-impairing effect is small by comparison with that of other environmental factors, such as lack of fertile soil, inadequate supply of precipitation due to pavements and snow removal, and lack of sunlight because of the high buildings. This contention is borne out by the fact that in spite of existing air pollution, vegetation flourishes in city parks or wherever ample space is provided. However, space is at a premium in industrial cities so that vegetation is generally scarce. This is unfortunate because trees and shrubs are effective filters of the aerosol.

BIOLOGICAL EFFECTS OF AEROSOL

Some of the possible biological effects of the aerosol on human beings will be mentioned. Here, the reduction of sunlight, particularly its ultraviolet component, by both dust and nuclei comes foremost to mind. This reduction, however, cannot be considered as a serious disadvantage from the physiological point of view for the following obvious reasons: (*a*) Most city residents spend most of their daytime hours either indoors, or in subways, buses, streetcars, automobiles; (*b*) even in the absence of air pollution, sunlight in city streets is greatly reduced by the shading due to city buildings; (*c*) even in completely unimpaired sunshine, an effect of the actinic rays could not reasonably be expected, as civilized people generally expose only an insignificant portion of their skin to the sun's rays; (*d*) probably the most important argument is that the beneficial antirachitic effect of sunlight has been recognized as outweighed by its detrimental carcinogenic effect which causes a high incidence of skin cancer among outdoor workers.

With regard to the effect of the aerosol on the human respiratory system, very little factual data are available, although speculative inferences abound. Until the direct physiological reaction of the human body to all components of the aerosol is known, conclusions drawn from purely formal statistical correlations must be looked upon with suspicion. For instance, correlations between incidence of, or mortality from, respiratory diseases and mere "indices" of air pollution seem to be highly conjectural, as was emphasized by V. Conrad (4).

One of the few problems explored is the retention of condensation nuclei in the respiratory tracts. Wigand,[2] Wait,[2] and Amelung and Landsberg (2) have made a few measurements of the number of nuclei in the air inhaled and that of the breath exhaled. Their results, arranged and summarized in Table 5, show that the number of nuclei retained in our respiratory system increases with increased nuclei content of the air we breathe, even though the percentage retained decreases. According to

TABLE 5 RETENTION OF CONDENSATION NUCLEI IN HUMAN RESPIRATORY SYSTEM FOR VARIOUS CONCENTRATIONS OF NUCLEI IN AIR

Number of nuclei per cu mm inhaled	Average number of nuclei per cu mm retained	Average percentage retained
<50	16	66
50–100	24	37
>100	75	20

Landsberg (15), in city air containing 100,000 nuclei per cu cm, a person inhales every minute almost a billion nuclei which, according to Table 5, means that he retains in his system some 150,000 billion nuclei in the course of a year. Even if the body did not expel any of this inhaled material, the body's weight increase due to nuclei would amount to only 15 milligrams per year. Whether or not the nuclear substances are harmful is not known, but the acrid sensation felt at times in the throat, from the sulphuric acid in city air is, nevertheless, quite unpleasant. Some authors have also speculated that ions or electrically charged nuclei may be responsible for restlessness and psychological depression.

As regards dust, this component of the aerosol has, according to Gemünd,[2] less biological significance than the nuclei because of the relatively negligible number of dust particles in polluted air. Also the dust elements, due to their larger size, will be more easily filtered out of the air by the outer parts of the respiratory tracts. These and similar opinions, though plausible, should, however, be checked by direct experiment.

In general, this field offers as yet untouched opportunities for the physiologist, physician, bacteriologist, epidemiologist, physicist, chemist, meteorologist, and engineer to combine their knowledge and skill in fundamental research on the biological effects of atmospheric pollution.

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Predesign Research as Applied to Product Development

(*Continued from page 210*)

Following these three primary steps, the ideal specifications must be modified from the point of view of practical manufacturing requirements, requirements of trade standards and trade practices, limits of manufacturing cost, and finally in terms of expected trends within the industry.

When this work has been prepared completely for presentation to the interested parties, it is possible to replace individual opinion with actual provable facts before any engineering work or development work is undertaken.

It has been our experience that by using such a logical system of arriving objectively at the facts and the complete statement of the problem, the work of the development engineer or designer is greatly simplified. The results he can produce are far superior to anything he can accomplish without it.

Throughout all such studies as have been described, it must be borne in mind that to develop provable improvements within a product it is necessary to consider and evaluate a great many diversified and complicated factors. This cannot be done well unless the problem is approached scientifically, nor can it be done completely unless a logical means of tabulation and analysis which insures full consideration of all factors involved is used.

Some Engineering Aspects of Quality Control

(*Continued from page 207*)

should there be a temporary breakdown in the normal manufacturing protective controls. The continuing results indicate either satisfactory quality control of finished product, or the presence of disturbing elements which are not due to chance causes, and which are therefore subject to identification and elimination. The results also indicate incipient trends which can be corrected promptly.

CONCLUSION

This particular application of quality control has been mentioned since it is believed that, while it may be unique in some respects, it does emphasize one of the most important advantages which can be derived from applying quality-control techniques. Management no longer has to base important decisions on the assumption that a production setup is delivering product of satisfactory quality, it now has a means of knowing.

It should also be emphasized that the degree of reliance top management can place in the quantitative information, which it secures through quality-control techniques, depends largely upon the continuing support given to this work and the extent to which this support is plainly evident to all levels of personnel.

What the LABOR-MANAGEMENT RELATIONS ACT *of* 1947 MEANS *to* EXECUTIVES

By JOHN R. BANGS[1] and JAMES W. TOWNSEND[2]

THE Labor-Management Relations Act of 1947 is but a chapter in the history of industrial relations. It was needed to protect the worker himself and his employer from unscrupulous and sometimes un-American labor leaders, just as much as the Wagner Act was needed in 1935 to protect the unions from unscrupulous and sometimes too-selfish managements.

The Wagner Act provided:

1 Protection for the working man and the union from an overdominant employer.

The Taft-Hartley amendment to the Wagner Act adds:

2 Protection of the public and working man from unscrupulous union leadership.

3 Protection for managements in their dealings with unions.

Since our task is to discuss the implications for executives in the Taft-Hartley Act, and since many accurate and detailed discussions of the provisions of the new Act are available, no attempt will be made here to recite what the Act says or what its individual provisions are. We shall, instead, develop from those provisions twelve major implications for executives that we find in the Act. No doubt there are others, and as the months and years pass, there will be more.

1 *Management Must Exercise Restraint, Good Judgment, and Common Sense in Using the New Rights Granted It Under the Taft-Hartley Law.*

The Act makes it easier for management to sue unions and to charge them with unfair labor practices. In addition, through the liberalizing of the free-speech right, management can more vigorously and effectively combat union propaganda.

These new privileges must not be abused. Management should and must comply with the Act to be sure, but this does not mean that they should seize upon technicalities to sue a union or to attempt to take advantage of a given situation.

The courtroom is a poor place in which to conduct a company's labor relations. The place is in the shops and work places where worker and management are thrown into daily association, and at the bargaining table where each side has equality under the law.

Industrial executives must take the lead in sound labor-relations thinking. To further this end, they should use their plants as laboratories for gathering facts and experience. Through their personnel and public-relations departments, they should make this information available to the joint committee on labor-management relations. Only in this way can progress be made, mistakes corrected, and worth-while additions made.

2 *Management Now Has a Broader Right of Free Expression*

The first amendment to the Constitution states, "Congress shall make no law...abridging the freedom of speech or of the press..."

The NLRB in interpreting the Wagner Act, at least until very recently, seemed to forget the meaning of these words. Congress remedied this situation by writing the following into the Taft-Hartley Act:

Section 8 (c).

> The expression of any views, argument or opinion, or the dissemination thereof, whether in written, printed, graphic, or visual form, shall not constitute or be evidence of an unfair labor practice under any of the provisions of this Act, if such expression contain no threat of reprisal or force or promise of benefit.

The striking fact here is the failure of management to use this new right. Management owes a duty, we believe, to its employees to advise them on union matters with which they are not familiar.

But, apparently, management has "missed the boat." A nation-wide survey of more than 500 companies of all types and sizes in the manufacturing industry, published in the October, 1947, issue of *Factory Management and Maintenance*, showed that only 79 companies (less than one sixth of the total) replied *Yes* to the question: "Is your company taking any steps to explain to your employees how the Taft-Hartley Act will benefit them as individuals?"

Have we then, as executives, taken full advantage of this new privilege? Have we made sure that all employees are informed of the truth of the Taft-Hartley Act?

3 *The Status of Foremen Has Been Defined.*

The new act provides that foremen and supervisors as members of management are in a different category from employees, and therefore companies do not have to bargain with organizations of supervisors. Will company executives be wise enough to treat their foremen with the respect and dignity due them as members of management so that they will be willing to deal with their companies on a man-to-man basis and will not feel the need for the security attained by collectivism?

The law does not mean that supervisors, in the eyes of the law, cannot strike. They can. They are not, to be sure, accorded the privileges of the Act, but there is nothing to stop their organizing as before.

The implication here is clear: Thoughtful executives will see to it that supervisors are in fact a part of management and will make it easy for them to meet with top management, adjust their problem, and be given the sense of really belonging to the management family.

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Contributed by the Management Division and presented at the Annual Meeting, Atlantic City, N. J., Dec. 1-5, 1947, of The American Society of Mechanical Engineers. Slightly abridged.

We cannot stress this implication too strongly. It goes to the grass roots of management—the front-line supervisor. Now that the legal bars are down, top executives have an even greater responsibility to their supervisors.

4 *Evidence in Unfair Labor-Practice Cases Is Now More Nearly Governed by Basic Legal Principles.*

No longer can charges of unfair labor practices be based on facts more than six months old. If companies have a spotty past in labor relations, they may turn over a new leaf; and if they persist in these reforms for six months or more, the past will be forgotten. This encourages self-correction. Executives should profit by this if they are in doubt about their company's past practices.

Under the old Labor Board procedures, not only was the age of the evidence immaterial, but many decisions were based on hearsay, gossip, and back-fence chatter of all kinds. Often it also seemed as if the witnesses had fertile imaginations. Henceforth the complaining party and the Board must have a strong case based on evidence presented as nearly as possible according to standard legal rules of evidence. Many times employers were ordered to reinstate or give back pay to an employee who was suspended or discharged for good cause merely because the claim was set up, by the union or the accused, that he was a "union man" and was being disciplined for that reason.

The Act corrects this and once again gives companies the opportunity of cementing their labor relations. The object of the provision relating to evidence in cases pertaining to discharge, "for cause" was, according to the House report, to end the belief, now widely held and certainly justified by the Board's previous decisions, that engaging in union activities carried with it a license to loaf, wander about the plant, refuse to work, and waste time.

5 *The Act Recognizes Unfair Labor Practices by the Unions and Their Agents.*

Under the new Act the principle of "clean hands" is applied to unions as well as to management. Unions cannot coerce employees and cannot coerce employers. Unions, too, must bargain, and they cannot engage in unlawful boycotts or jurisdictional strikes. The implication arises from whether or not executives will stand up for their newly acquired rights and insist that the unions comply, not only for their own protection but, more important, for the protection of their employees and the public.

Before the Senate Committee on Labor and Public Welfare, investigating the need for a new labor law, many shocking instances of union practices were cited by the witnesses. It was the object of the Congress in writing this section of the statute to make the unions behave themselves in relation to the employees, the employer, and the public. Executive implication is here quite clear.

6 *The Present Trend in Labor Relations Is Toward the Secret Ballot.*

Executives must become familiar with the various voting procedures under the Act. The tendency in labor disputes is toward voting. Under the new law, craft unions, as old contracts expire may, if the voters so elect, take over the representation of skilled men. Thus management may find itself bargaining not with one plant-wide union, but with many unions, i.e., machinists, tool and die makers, patternmakers, electricians, and pipe fitters. The fact that guards may no longer be part of a production unit and that professional employees also may choose to set up their own units indicates many executive headaches in the offing.

The fact that there is this definite trend in the history of labor relations toward increasing the use of democratic principles when the "chips are down" is a healthy sign and executives should not be too quick to condemn it even though it may pinch a little. Such matters as a union shop, check off of union dues, disestablishment of a union as well as establishment of a union, are all worthy subjects for the ballot.

The Federal Mediation and Conciliation Service's secret ballot to determine the employees' acceptance or rejection of the employer's last offer of settlement is yielding valuable results. As of early fall, 80 elections have been held and in 31 cases the employees have agreed to the terms of the final offer. In 25 cases the workers turned down the offer. The results of remaining cases have not as yet been recorded. Here, clearly, 31 or more strikes have been avoided by the voting procedure.

The increased voting rights of the worker present an important implication for executives.

7 *Employees May Now Present Their Grievances Directly to the Company.*

The Taft-Hartley Act allows employees to present their grievances directly to company officials. Previously, if an employee did not belong to the recognized union, many times his grievance would not be processed; or, if he spoke out of turn in the meetings, he was sometimes, in addition, tossed out of the union, fined, or given the "silent treatment." Now he may personally take his grievance to the company and the company may settle it with him provided: (*a*) The settlement does not violate the terms of the existing contract; and (*b*) the union is given the opportunity to be present at the final settlement.

The implication for executives in this section of the Act has real import. Once again the management is given the opportunity to know its employees more intimately. Many times the Wagner Act drove a wedge between the employer and the employee. The worker heard little but the word of the union propaganda machine. The employer could never talk back without risk of prosecution. Many times his talking to an employee was in itself the cause of a grievance. Now they may deal together directly on a business basis. If executives use this grievance privilege wisely, they will encourage peaceful labor relations and better understanding.

8 *Union Membership Is Encouraged to Expose and Eliminate Un-American Officers and Agents.*

The new Act tends to encourage all employees and their companies to stand up for American principles and to fight organizations that advocate the overthrowing of our government and our way of life. The fact that some unions fight it so hard is indeed indicative of the strength which subversive elements have obtained in many professional union organizations.

It does not help us to say there are but 2 or 3 per cent communists in the labor unions. These figures are extremely misleading because, for every communist, there are about 10 fellow travelers.

So let's be realistic. The communistic infiltration into unions is fraught with danger.

The implication: Drive the communists out of American labor organizations.

9 *Collective Bargaining Has Been Defined.*

The Wagner Act did not define the term "collective bargaining." The rules under which labor and management operated were the result of experience and NLRB decisions. The Taft-Hartley Act seeks to remedy this situation. Section 8 (d) of the Act reads, in part, as follows:

> ....to bargain collectively is the performance of the mutual obligation of the employer and the representative of the employees to meet at reasonable times and confer in good faith with respect to wages, hours, and

other terms and conditions of employment, or the negotiation of an agreement, or any question arising thereunder, and the execution of a written contract incorporating any agreement reached if requested by either party, but such obligation *does not compel either party to agree to a proposal or require the making of a concession:*[3] . . . .

We believe this latter phraseology is a most important implication. Note, it says clearly neither party is obligated *to agree to a proposal or required to make a concession.*

Apparently both the Congress and the NLRB recognized the distinction between a counteroffer and a concession. We are told on good authority that both groups wanted the word "concession" written into the law in order to avoid any misunderstanding.

As we understand this distinction, a counteroffer to a demand for a pay increase of, let us say, $11^1/_2$ cents per hour *may be an offer to continue to pay at the present rate.*

Under bargaining as defined by the Taft-Hartley Act, such a counteroffer may be necessary, *but a concession of five cents per hour, for example, is not required.*

Since no concession is required, it would seem that no union would have the right to demand that an employer disclose his financial condition when the union asks for a pay increase; and we believe that failure to give this information is not a violation of bona fide collective bargaining.

The implication, as we see it, is that whether or not an employer can afford to grant an increase is now irrelevant because the Act expressly states that no "concession" is required.

Another direct implication arises under collective bargaining. The new Act states in the first unfair labor practice for unions, that they (the unions) must not coerce an employer in his selection of representatives for collective bargaining or grievance procedure.

This will put a stop to unions trying to dictate who would represent the employer in grievance procedures or trying to make an employer remove his personnel manager who is authorized to act in grievance matters.

There are also definite legal restrictions on welfare funds, trust funds, and the like, and on the payment to union officers and representatives of any money or anything of value other than for services rendered. Violation of this latter restriction is now made a crime, although it is generally believed that payment to union officers or representatives for time spent during working hours in discussion of grievances with company officials may be made at the employee's regular rate without violating this provision.

This is based on a still active provision of the old Act, but the law is still uncertain as to whether or not an employer may now pay average earnings to a union negotiating committee during collective-bargaining negotiations, especially when such negotiations extend beyond regular working hours or include union conferences, not attended by company officials, between regular negotiating meetings.

The fact that companies and unions cannot agree to check off union dues without a written authorization from the employee is a limitation on the bargaining, and these check-off authorizations, if irrevocable, must not be irrevocable for a period of more than one year.

The implication in these bargaining matters is that both the union and the employer must in these matters think in terms of the employee. This is an implication no one can overlook.

The sixty-day termination notice for contracts before a strike may be called and the thirty-day notice to the Federal Mediation and Conciliation Service, as well as the other strike limitations, are all aimed at guiding the hand of the negotiator toward sound businesslike methods, keeping the worker's right to work and to receive his pay, without unreasonable or unauthorized deductions, paramount.

10 *Utilities and the National Welfare Are Protected.*

Labor strife in public utilities or in industries of national scope, such as coal, steel, and transportation, can paralyze the whole country, causing terrific hardship and even loss of life. Furthermore, such tie-ups in the hands of un-American people would set the stage perfectly for a lightning attack on our country. No effort should be spared by executives to prevent such tie-ups. The Taft-Hartley Act has attempted to provide the means for settling disputes of this magnitude peacefully and with emphasis on publicizing the information, rather than by force or actual prohibition of strikes, except as regards Government employees.

The Presidential Board of Inquiry, the issuance of a court injunction, the reports to the President, the secret ballot of employees as to whether or not they accept the employer's last offer, and, all in all, the total 80-day cooling-off period, are designed to prevent a repetition of a long coal, power, or transportation strike. These provisions apply to all types of industries in interstate commerce except employers and employees of railroads and air-transport companies subject to the Railway Labor Act.

Many people believe that strikes of this nature should be absolutely abolished and made a crime. Others consider it to be no less than treason, but the American way is to urge people to think clearly and use judgment in such matters rather than to be forced at the gun point. This is a very serious matter and in settling these disputes executives of both unions and managements cannot fail. The implications involve the very future of our country.

11 *Some Union Leaders Are Attempting to Avoid, Circumvent, or Repeal the Taft-Hartley Act.*

When the Act was passed there was a terrific barrage against it from union leaders. They said they would not comply; they would get around it; they would repeal it by forcing the defeat of all congressmen and senators who voted for it.

Some companies allowed their new contracts to contain provisions limiting union liability; others agreed not to sue at all; other plans were experimented with. Most of these clauses were well thought out by both sides; they tried to follow the spirit of the Act. Unfortunately, however, some were not so well done.

By-passing the NLRB is one method of circumvention. One large national union that refused to file a noncommunist affidavit recently obtained recognition in 16 cases without going before the Board.

Union leaders do not want to be sued any more than you or I do. But is it not right and proper for anyone or any organization to answer for its misdeeds? We believe that union leaders with sound principles will actually welcome their newly clarified status.

We believe very few employers will sue the unions. They could do so in the past; the Taft-Hartley Act, however, makes it easier now. Far-seeing executives will use this right very discreetly. We must live with the unions and our employees from day to day, and productive efficiency is not improved by holding a lawsuit over the heads of the unions.

We have read a great deal lately about certain union leaders refusing to file noncommunistic oaths required under the new law. Does anyone think for one moment that communists want employees to give efficient uninterrupted production?

There are those in labor's ranks who have pledged themselves to defeat all congressmen and senators who voted for the Taft-

[3] Emphasis supplied.

Hartley Act and are now raising funds to accomplish these ends.

"The Labor Law Will Be Repealed If You Don't Watch Out" is the title of an article in the October, 1947, issue of *Factory Management and Maintenance* that all management should read, study, and digest.

The Taft-Hartley Act will be repealed if union leadership has its way. Herein lies a most important implication for all executives.

12 *Executives Must Possess More Courage and Wisdom in Labor Relations Than Ever Before.*

There are many other implications for executives, but the last of the more important ones we feel is most fundamental of all: Are the executives of both labor and management strong enough, and do they possess the necessary leadership qualities, to take this legal skeleton and add to it the sound flesh and blood necessary to mold it into a living reality? Can they with this law as a beginning mold more businesslike relations between management and labor? Congress, fortunately, has made this possible through Senator Ball's standing joint committee. In the main, the principles of this Act are sound and should accomplish the goal of increased production through more businesslike and less hysterical labor relations, if executives do a good job of carrying out its provisions.

Will executives tell their employees the truth about the Taft-Hartley Act, or are they afraid to do so? The union executives have not been afraid to speak against the Act, even to the extent of using the English language rather loosely to call the Act a "slave-labor law." It is just the opposite. They have told to their public that the rights guaranteed under the Wagner Act, labor's "Magna Charta," have been destroyed, when, in fact (and these same labor leaders admit it in private), the whole of that Act, except for a few technical points, is still as much in effect as before.

So far, executives have done a rather poor job in telling the public about this Law.

CONCLUSION

As this conclusion is written, there appears one more survey. A nation-wide study by *Factory Management and Maintenance*, published in the November, 1947, issue, points out these strong implications:

1 Most workers admit they know little or nothing about the Taft-Hartley Law—but the majority say they want changes or repeals, even though they have few specific criticisms.

2 As yet only one worker in ten has been affected by the Taft-Hartley Act—but one in three expects to be worse off under this new law.

3 Workers do not expect the Taft-Hartley Law to be the chief cause of strikes in 1948—nor do they expect as many strikes as in 1947.

Echoing this last thought we, as executives, can have reason to feel the Act is working. Strikes are diminishing. The trend is distinctly downward since the Taft-Hartley Act was passed in June, 1947.

There were 221 strikes involving 101,000 workers during the first week of the new Act. A check on Oct. 15, 1947, showed a decline to 104 strikes involving only 32,000 workers, according to the Federal Mediation and Conciliation Service.

These figures do not cover all strikes, since some are not handled by the Federal Mediation and Conciliation Service. They do, however, cover the important ones.

The decline is due in part to seasonal factors, but we believe much of it is because of the enactment of the Taft-Hartley Act. The Act is in the testing stage and everyone is cautious. Contracts for the big companies do not expire until the spring of 1948. So for the present, strikes will decline, with the big test in 1948 when the curve may begin to rise again.

In the meantime, the number of disputes handled by mediation is increasing and is running at about the same level as 1946, but the number of strikes has been cut in half.

In six weeks, 8208 union officers filed noncommunist oaths with NLRB.

On the basis of early returns, the Act appears likely to prove effective against secondary boycotts and jurisdictional strikes.

As a final sign of encouragement, NLRB statistics show that management is using the new Act discreetly. There is no evidence that companies are using it as an antiunion device. To illustrate: Between Aug. 22 and Sept. 30, 1947, NLRB reports the filing of the following unfair-labor-practice charges: 42 were filed by management, 27 by unions, and 333 by individuals. Of the 333 filed by individuals, 305 were filed against employers, and 28 were filed against unions.

During the same period, the following number of election petitions were filed: 106 by unions, 62 by individuals (58 for decertification), and 35 by employers.

Management, judged by the cold facts of the case, is using the new law with restraint, good judgment, and common sense.

The Act *will* work, the Act *is* working, despite adverse publicity by some union leaders.

It calls for statesmanship on both sides.

It has increased the responsibility of the parties to achieve a higher degree of co-operation and peace between management and labor. It is up to the better-thinking executives of management and labor to settle down, get together, and keep it working.

We need increased production to feed and rehabilitate a war-sick world, for the preservation of our free enterprise society and for the maintenance of our high standard of living for all.

To achieve this end, we must have sound businesslike labor relations with a restoration of faith in each other by both management and labor.

The law calls for statesmanship on both sides.

And, as we move into this new era of labor-management, let us repeat: *the Taft-Hartley Act is working.* Aided by statesmanship on the part of both labor and management, it will continue to work.

It will act as a powerful instrument for attaining industrial peace. It will aid the engineer and his fellow industrialist to increase national productivity.

INVESTIGATIONS with a down-to-earth flavor are those on house building, furnace tending, and other domestic subjects at the University of Illinois, according to *Science and Appliance*, December, 1947. They yield practical pointers on coal storage, selection of house hardware, waterproofing walls, and the like.

Actual houses and ordinary living conditions make the projects realistic. About the only difference between the experimental dwellings and the houses for which the information is intended is the presence of gages and the taking of readings.

The furnace project has been going for a number of years in the warm-air-heating research residence. Now the spot has become a community, "the Small Home Research Center," with the new "minimum house"—two small bedrooms, bath, combination living-dining room, kitchen-utility room, and basement—and two more buildings, one for floor-slab research and an office.

The new house will be the scene of several studies. The asbestos shingles will be two feet wide—usual is 16 inches. The roof will be aluminum shingles. The furnace will be a professor's invention, designed to burn soft coal without smoke. The place as a whole will be studied to see how a family of three can get along in cramped quarters.

UNION-MANAGEMENT CO-OPERATION[1]

By CHARLES A. MYERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MANY American managements realize that good union-management relations at the plant level are not achieved by laws and government intervention, but rather by management and union leaders sincerely trying to understand each other's problems and working toward agreements which each can accept. Although this sort of understanding is growing, the idea of "union-management co-operation" is still in its infancy. Some firms have been willing enough to have the union "co-operate" on their terms, but few have been willing to pay the price of genuine co-operation: the acceptance of the union as a partner in meeting and solving problems, such as production and marketing problems, which are outside the traditional scope of collective bargaining.

One important reason for this reluctance to extend the scope of collective bargaining is a concern for management's "prerogatives" or "rights;" a fear that unless it can take action quickly, management will not be able to do its job effectively. Perhaps there is also the suspicion that if the union participates in the solving of production problems, management's status and prestige will be undermined. It is not surprising therefore that most of the union-management co-operation plans have developed in firms which were pushed to the wall by economic necessities, leaving management with no alternative but to accept the proposal of the union for full-fledged co-operation, if the firm were to survive.[2]

The book under review[3] deserves the close attention of those in management who now believe that it is unwise to permit an extension of the traditional scope of collective bargaining by encouraging union-management co-operation. The Brookings Institution, a privately-endowed group "devoted to public service through research and training in the social sciences," has made an important contribution in publishing this study of the experience with union-management co-operation in the clothing industry. Much of the material was already available in scattered books and monographs, but Mr. Braun has tied it together and supplemented it with information which he gathered through oral interviews and correspondence with management and union officials in the industry. His conclusions are particularly significant, and, incidentally, in rather sharp contrast to some of those reached in two earlier and much less scholarly Brookings studies on national labor policy.

THE NATURE OF THE CLOTHING INDUSTRY

The two main branches of the clothing industry are men's clothing and women's clothing, and two unions, the Amalgamated Clothing Workers of America (CIO) and the International Ladies' Garment Workers Union (AFL) dominate these two branches, respectively. The first was headed by Sidney Hillman until his recent death, and the second is headed by David Dubinsky. There are also a number of employers' associations, and collective bargaining increasingly is conducted on a market-wide and even nation-wide scale.

Labor costs are a higher percentage of total product costs than in manufacturing generally (23 per cent in men's clothing as compared to about 16 per cent in all manufacturing industries), and in many firms, particularly the "contractors," the percentage is much higher. The size of firms is small, and "manufacturers" and "jobbers" frequently farm out work to contractors or "outside shops." In the past, before the unions became strong, competition drove down wages since contracts for work went to the lowest bidder and bids could be lowered by wage cuts. Union-management relations were characterized by strikes, intensified organization of outside and "runaway" shops, and efforts to regulate and stabilize the whole manufacturer-jobber-contractor system. Today, according to Mr. Braun, there is a considerable measure of stability, and "employer-employee relations in this industry now present an example of unusually close and extensive union-management co-operation."

THE AREAS OF CO-OPERATION

What are the areas for co-operation in this industry? Mr. Braun's definition of union-management co-operation is broader than the one generally used, for he believes that "the first stage . . . is reached when collective bargaining does not take place merely because of the pressure of statutes, but is motivated, irrespective of existing law, by the desire to settle management-union relations through voluntary mutual understanding." Thus the unions "co-operated" with management in introducing piecework methods of wage payment; setting piece rates; stabilizing labor costs for particular grades of garments; sharing work in slack times; providing for dismissal compensation and guaranteed employment; introducing cheaper lines of clothing; stabilizing production by reducing seasonal fluctuations, regulating trade practices such as style piracy, discount terms, secret rebates, etc.; developing of welfare plans, including old-age and retirement funds, unemployment compensation, and health and vacation funds; and settling of labor disputes through establishment of permanent arbitration systems.

But the most striking area for co-operation—and the one generally considered when the subject is discussed in relation to other industries—is in increasing efficiency and (less frequently) improving marketing practices. The International Ladies' Garment Workers Union has taken the lead in this field, with the establishment in 1941 of a Management Engineering Department, headed by a professional industrial engineer.[4] Among other things, this department assists firms in

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Union Policies and Industrial Management," by Sumner H. Slichter, The Brookings Institution, Washington, D. C., 1941, p. 565.

[3] Union-Management Co-Operation: "Experience in the Clothing Industry," by Kurt Braun. The Brookings Institution, Washington, 1947.

[4] The Director is William Gomberg, mem. ASME, whose writings have appeared in Mechanical Engineering and other professional journals. See, for example, his article, "The Relationship Between the Unions and Engineers," Mechanical Engineering, June, 1943, vol. 65, pp. 425–430; and "Union Interest in Engineering Techniques," *Harvard Business Review*, spring, 1946, vol. 24, pp. 356–365.

efforts to improve manufacturing techniques and operating methods, trains shop committees in time-study practices, and assists in setting new piece rates. Its efforts are tied in with the "efficiency clause" which was included in the 1941 agreements in the New York City dress market. In this clause the union and the employers' associations agree that, among other things, "each manufacturer shall operate his shop in an efficient and well-ordered manner." Similar, but less formal arrangements, have characterized the men's clothing industry.

THE NEED FOR GREATER EFFICIENCY

Why should the union concern itself with these matters, or why should employers agree to joint responsibility for efficiency? Part of the answer, but not all, lies in the nature of the clothing industry. Especially in the smaller shops, managements were not aware of newer production methods and practices. In the past, competition between firms in this industry apparently did not bring more efficient operations; but it frequently brought wage cuts. So the union had an interest in developing greater efficiency which would make possible the stabilization of workers' earnings at a higher level. In the New York dress industry, another motive was undoubtedly to recoup some of the losses to other clothing markets and to promote the New York market. The "promotion clause" in the same 1941 agreements resulted in the establishment of the New York Dress Institute in which both employers and the union combined to promote New York fashions throughout the country.

The motives for employer acceptance of this program are less clear. There is evidence that they were "compelled" to accept it by a strong union, but "under the influence of constructive and conscientious leaders, understanding for the specific interests of the other group grew on both sides." Management has recognized that the unions can make positive contributions to greater efficiency. As one men's clothing manufacturer stated: "The company contends that its labor costs are too high. The union alleges that the difficulty is not in labor costs but in manufacturing efficiency and merchandising skill. As it happens, the union is in a position to develop reasonably good judgment on manufacturing efficiency and its contentions have often been correct."[5]

Management has also won acceptance of incentive methods of wage payment, which formerly were bitterly opposed by the unions. In addition, it has "gained a considerable amount of good will on the part of the unions and workers. If, on the one hand, the employer can no longer do business without, or with but little, regard for his workers' specific interests, the union, on the other hand, cannot and does not pursue policies which give no consideration to the industry's interests. Labor has become more industry-minded and has a greater incentive to concern itself with improving efficiency and productivity."

EFFECTS OF CO-OPERATION

Has union-management co-operation in the clothing industry been worth while? Some of the intangible benefits, described in the preceding paragraph, are difficult to measure. Mr. Braun, however, tries to assess the program in terms of employment, wages, profits, prices, and industrial peace. The data are not conclusive, for general business trends and the war have been strong influences, as has the development of industry-wide bargaining in the industry. Nevertheless, Mr. Braun observes that "in practice expanding co-operation compelled them (the unions) to assume, by and large, a sober and realistic attitude with respect to wage-profit-price relations." Wages have been raised appreciably, but not out of proportion to wage levels in other industries. "A number of employers are convinced that, without collaboration, wages—and profits—would have gone up higher in good times and gone lower in bad times. They appreciate this stabilizing effect of union-management co-operation, although they feel that they have had to pay a price for it."

Prices to consumers have risen, but no more so than in other industries which lack union-management co-operation or industry-wide bargaining. Competition between manufacturers still helps keep down nonwage costs, and sets limits on price increases. Mr. Braun concludes: "Clothing manufacturers and unions generally appear to have respected those limits. Their wage-profit-price policies have not resulted in selling prices out of proportion to the general price level." Furthermore, consumers and the public generally have benefited from the absence of strikes and lockouts in this industry. "Serious interruptions of production have not occurred for a long time. Nobody has had to worry about industrial warfare in this industry; nor has labor strife prevented customers from obtaining clothing."

SIGNIFICANCE FOR OTHER INDUSTRIES

In drawing conclusions from his study for other industries, Mr. Braun is very careful to distinguish between what he calls "two issues" in union-management co-operation. First, the co-operative approach to collective bargaining which characterizes the clothing industry has significance for other industries because, with it, "unions can be expected to attain a better understanding of managerial problems and to become more industry-minded. Industrial self-administration will be facilitated and government intervention thus forestalled. A good prospect is offered that union resistance to technological change will decline. Union officers and workers are likely to have an interest in the smooth functioning of the establishment. Productivity thus may increase, and it can be expected that workers and unions will support fully management's efforts to maintain the degree of shop discipline necessary for efficient production. Finally, wherever genuine co-operation prevails, both parties will bargain and work together with the serious intent to make not only demands but concessions if this seems appropriate in view of the important interests of the other party."

But in the second aspect of co-operation—the scope of collective bargaining, the clothing industry "cannot provide a formula for industry as a whole," according to the author. Yet the whole study seems to point to sharper conclusions than the author draws on this issue. If managements view the protection of their prerogatives or rights as the central problem in collective bargaining—if they have as their chief aim in union-management relations the "containing" of the union within a narrow sphere of activities and responsibilities, then they can hardly expect to get real co-operation and understanding from union officials or probably from employees who are union members.

On the other hand, if managements worry less about the protection of prerogatives as such, but concern themselves with problems to be solved, with whatever help they can get from any source (unions included), the scope of collective bargaining is not likely to be much of a battleground in their labor-management relations. This seems to have been true in the clothing industry, as well as in plants where the Steelworkers have pioneered in union-management co-operation in production problems.[6]

[5] "A Study of Management Prerogatives," by Meyer Kestenbaum, *Harvard Business Review*, vol. 19, autumn, 1940, p. 97.

[6] As an example, see the discussion of one plan by the Steelworkers official who was responsible for the union's part in it; "Adamson and His Profit-Sharing Plan," by Joseph Scanlon, Production Series No. 172, American Management Association, New York, N. Y., 1947.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Army and Air Force Research

AN unclassified summary of the 1949 Research and Development Program of the Department of the Army and the Department of the Air Force prepared by the Plans and Program Office of the Research and Development Division, General Staff, U. S. Army, has recently been made available. Classified material has been omitted, but every effort has been made to give as true a picture of the program as is consistent with national security.

The research plan consists of two separate programs, one for the Army (Technical Services) and one for the Air Force (Engineering Division, Air Materiél Command).

In general, the research and development programs in the peacetime period will be placed in the highest priority. Also, the research and development agencies of the Army will utilize to a maximum, on contract basis, civilian educational institutions and industrial laboratories for the solution of problems within their scope.

Research and development will proceed vigorously and with forward-looking vision to maintain the high standard and superiority of our weapons and equipment, to guarantee the availability of proved types, superior in all respects to those of other nations, and to constantly maintain a lead position in the creation and fabrication of all items essential to ground and air supremacy. This will require among other things a continuing evaluation of foreign research and development activities.

Research and development laboratories, proving grounds, and service boards will be maintained and operated as required for conducting research, development, and test of military equipment, and will be prepared for rapid expansion. Facilities will not be maintained and operated which may be adequately provided by commercial organizations, educational institutions, and laboratories.

It is pointed out that the War Department will take advantage of civilian talent, facilities, and assistance in military planning and in research and development, as well as planning the production of newly developed weapons and equipment. Long-range planning must envision the potentials of science and technology.

Some of the items of current interest in the program follow:

ARMY

With regard to atomic energy and fission products, the Army has under continual study the military applications of atomic energy and from time to time as possible applications are evolved, requests are sent to the Atomic Energy Commission to study the feasibility of such applications with a view to supplying the means of accomplishing the desired end. Possible applications include the fields of power, weapons, chemistry, and medicine.

Future research and development in the field of rockets and launchers includes the following:

New compositions of rocket propellants have been proposed for study and thorough investigations of the characteristics must be accomplished. Fundamental studies will be undertaken to determine the temperature coefficients of various compositions of propellants. Studies of the reaction mechanism and high-temperature gas kinetics during burning will be made in order to eliminate or minimize the dependence of burning rate on pressure and temperature. Manufacturing methods for large grains will be devised and improved. Stability investigations will be conducted. This work will point toward the development of propellants which will meet the stated requirement of the user for rockets and jatos which will have a satisfactory operating temperature range.

The basic studies on jatos include the determination of the suitability of lightweight metals for the construction of rocket motors. Heat-resistant metals and insulating materials will be investigated to select types which are applicable to rocket chambers.

Ballistic studies and tests will be conducted to secure additional data for the rational design of rockets. These tests will include means of determining the causes of the dispersion of rockets and ways of making improvements. Studies of the exterior ballistics on both fin-stabilized and spin-stabilized rockets will be made to determine best application of each type.

New propellants and further knowledge on the behavior of rockets will permit the development of larger sizes, greater accuracy, and longer ranges with high pay loads.

The studies on launchers for these rockets is directed toward simplicity of construction, reduction in weight, better roadability, and increase in the rate of fire.

For guided missiles, rocket motors of various sizes have been built and tested which exceed German V-2 motors in performance. Research is being conducted on motor design, new high-energy solid and liquid fuels, propellant feed systems, and the like.

Work will be continued to provide propulsion units of increased life and efficiency and decreased weight and volume.

In addition to the fundamental problems connected with propulsion, aerodynamics, and control, there is a great deal to be learned of the characteristics of the earth's atmosphere at the very high altitudes at which missiles are to fly. The Ordnance Department will continue to assist other agencies in every possible way in investigations of the upper atmosphere.

Future research in the field of fuels and lubricants will be devoted to the study of the basic chemical and physical nature of fuels and lubricants and the relation of these properties to the phenomena of lubrication, combustion, and rust protection. In addition, many new synthetic materials which show promise as lubricants are being made available by industry. A number

of these materials are currently being investigated for possible application as fire-control-instrument lubricants and as recoil and hydraulic oils.

Requirements for present equipment cover development of radar sets, for utilization of detection and fire control, to establish a long-range navigation and survey system for meteorological radar sets suitable for obtaining data on atmospheric conditions, and equipments for detecting and tracking guided missiles. Transmission of radar data and their presentation in a manner suitable for interpretation of a wide-scale basis is closely related to the development of radar equipment itself in order to improve wide-scale operation and value of the basic radar equipments.

Research on basic theories is continuing to obtain data for increasing ranges, for bettering resolution and accuracies, widen band of frequencies over which radar equipments may operate, and develop new methods of constructing and utilizing radar equipments. Under research are methods of operation which will improve performance of radar equipment greatly beyond that now enjoyed by the most advanced sets. It is required that this improved performance be obtained without increasing requirements for band width in the already crowded electromagnetic spectrum.

In addition, research and development are to be carried out on such items as chemical warfare, cold-weather research testing, petroleum-distribution equipment, infrared equipment, ordnance in general, refrigeration equipment, metals and metal applications, fuels and lubricants, management studies, communications, and transportation.

AIR

Future research and development in the field of reciprocating engines will be directed toward development of trainer, helicopter, and accessory engines only.

Future research and development in the field of gas-turbine engines will be required to provide engines of higher output with greater internal efficiencies and with improved components of construction.

The present turbojet-development program is directed toward the development of turbojet engines which vary in size and output from 3275-lb thrust at take-off and a minimum specific fuel consumption of 1.16 lb of fuel per lb thrust per hr cruising, to 20,000-lb thrust at take-off with a minimum specific fuel consumption of 0.89 lb of fuel per lb thrust per hr at cruising.

The present turboprop-engine development program is directed toward the development of turboprop engines which vary in size and output from the present 1700 equivalent bhp at take-off with a minimum specific fuel consumption of 0.49 lb of fuel per equivalent bhp per hr at cruising, to 10,000 equivalent bhp at take-off with a minimum specific fuel consumption of 0.39 lb of fuel per equivalent bhp per hr at cruising.

Present technical knowledge in the field of ramjet engines is in the initial stages. Many theoretical studies have been conducted to date to obtain fundamental design data on subsonic ramjets.

In the field of pulsejet engines present technical knowledge is in the intermediate stages. The background obtained from study of the German V-1 power plants has been supplemented with data obtained from pulsejet power plants built for the Air Force and extensively flight-tested at Eglin Field Proving Ground and ground-tested at Wright Field.

Present technical knowledge in the field of liquid-propellant rockets is in its early stages. Background on liquid-type rockets has been obtained from studies of the German V-2 rocket power plant and the ME-163 power plant. Also, flight tests were initiated during December, 1946, on the XS-1 airplane incorporating a 6000-lb-thrust liquid-propellant engine.

In the field of ramjet-engine development, efforts are being directed toward the development and operation of a successful supersonic ramjet engine. To this end, considerable theoretical and laboratory research studies will be required to evaluate and determine fundamental ramjet components designs, combustion processes, and materials of construction.

Research and development in the field of liquid and propulsion rockets will be directed toward the refinement and perfection of usable rocket engines under all operating conditions. A large portion of the development program will be expended in developing engines and power plants now on contract to obtain component parts such as valves, basic engines, turbines and pumps, and controls that are efficient and reliable.

Research in the field of nuclear physics and high heat-transfer rates, as well as theoretical studies, are being carried out with an aim of obtaining suitable information upon which to base a design of an aircraft power plant. This research is being conducted by the NEPA Division of the Fairchild Engine and Airplane Corporation.

Work will be continued in co-operation with the Atomic Energy Commission, and problems involved in application of atomic energy to propulsion of aircraft.

Research and development will also be carried out in aerial photography; aerodynamics, aircraft structures, and structural components; aircraft armament, materials, and equipment; aviation fuels and lubricants; and numerous aircraft projects.

UNESCO

THE UNESCO program for 1948, which was prepared by the Executive Board of UNESCO for consideration at the Second Session of the General Conference in Mexico City, showed marked changes when compared with the 1947 program.

Of the many recommendations and suggestions made by the National Commission and included in the report, a number of those given priority by the Commission follow:

It was recommended that the highest priority should be assigned to educational reconstruction in the war-devastated countries and to fundamental education; that the Government of the United States continue its efforts to include the former enemy countries in the program of UNESCO for educational reconstruction; and that UNESCO organize an international conference on higher education for the consideration of such matters as university functions in the modern world and the equivalence of degrees.

UNESCO should not itself administer the details of the exchange of persons but should make available information respecting needs, opportunities, and standards, and should study the obstacles to exchanges caused by government regulations and seek remedial measures. UNESCO should maintain effective liaison with the fellowship programs of the United Nations and other intergovernmental organizations.

It was recommended that the high priority given in the 1947 program with reference to mass media, as approved by the first Session of the General Conference, be restored in the 1948 program, giving high priority to a survey of the press, the films, telecommunication, and postal services, looking toward the removal of barriers. High priority was also to be given to a consideration of the setting up of a radio network.

The Commission also recommended that UNESCO promote the international exchange of publications throughout the world. Recognizing the importance of international copyright, the Commission urged that the U. S. Delegation to the General Conference be instructed to support a satisfactory universal system of international copyright relations. An in-

ternational conference of experts in language teaching was recommended.

The Commission, attaching great importance to the project for the analysis of textbooks, recommended that the project be restored to the status approved by the First Session of the General Conference, that the responsibility of reporting instances of textbooks inimical to peace among nations should be undertaken, and that the analysis of textbooks should be extended to educational programs of nonmember states.

It was also recommended that the U. S. Delegation should support proposals for the investigation by the organization of education for international understanding.

It was urged that at least four seminars, using the techniques and methods of the UNESCO Teachers' Seminar on Education for International Understanding, held in Paris in the summer of 1947, be organized for 1948 in various sections of the world; that UNESCO hold a conference of experts in adult education in 1948; and that full consideration be given to the use of mass media as instruments of adult education.

It was recommended that the problems of tensions affecting international understanding be given a very high priority. It is important to find and reduce the tensions leading toward war, but it is even more important to recognize and strengthen the forces that are working for peace. Special provisions should be made for a study of tensions in the areas where they are most severe and where it is hoped that practical progress may be made toward the promotion of world peace.

The National Commission expressed emphatic approval of the statement in the program for 1948 respecting the formation of national commissions, and recommended that the U. S. Delegation be instructed to support the policy here expressed. Full co-operation with the United Nations and its specialized agencies, and with the related intergovernmental agencies was given special approval.

Automatic Focus Rectifier

AN automatic focus rectifier for mosaic map making, said to be the first ever produced in America, was delivered to the Army Corps of Engineers, Bausch & Lomb Optical Company announced recently. In addition to aerial reconnaissance work, the new photogrammetric instrument will be of significance in planning national throughways, soil-erosion studies, and flood control.

Resembling an ordinary photo enlarger, it simultaneously enlarges, prints, and automatically reduces aerial photographs to a common scale and level, correcting the tilt encountered as a result of the airplane's variation in angle and level at the time photographs are taken. Airplanes equipped with the most modern stabilizers can maintain a constant level only to within one-quarter degree accuracy, making the rectifier vitally necessary in production of precise aerial photomaps.

Equipped with push-button controls, the automatic instrument can be operated by a photographer, turning out rectified prints on a production-line basis at the rate of one every five minutes. Previous nonautomatic rectifiers required tedious involved mathematical calculations for each individual photograph.

Designed around the requirements of the Corps of Engineers, the rectifier will be available for commercial use this year. Small enough to be mounted on a trailer truck for use in field work, it has fluorescent illumination, an enlarging lens of high optical resolution, and is constructed to maintain constantly the proper alignment between the negative and printing easel.

Three push-buttons control tilt, magnification, and swing.

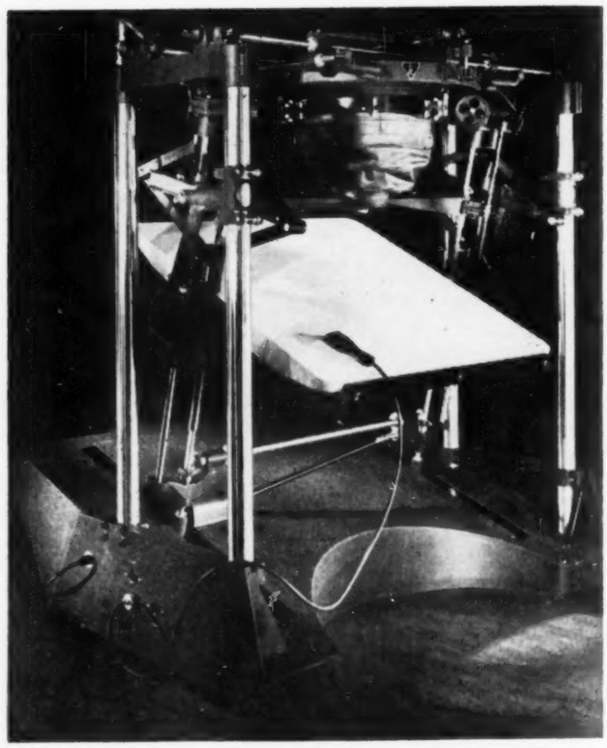


FIG. 1 AUTOMATIC FOCUS RECTIFIER

The first operates a device which compensates for the tilt of the airplane and can accommodate tilts as high as 20 deg.

A second button regulates magnification, automatically bringing photos taken at varying elevations to desired map scale. The remaining button controls swing, re-establishing in the instrument the airplane's angle of deviation from its true course.

Photographs of terrain printed with the new rectifier are said to be so sharply defined they give an almost three-dimensional effect.

High-Temperature Furnaces

A SERIES of extremely high-temperature research-laboratory furnaces has been announced by the Westinghouse Electric Corporation recently. One is capable of producing heats of 3100 F (1700 C), nearly 200 F hotter than ordinary laboratory high-temperature furnaces. Also, it has an effective heat zone of about four cubic feet, which means it can take a charge approximately four times larger than is customary.

It is a radiant-type furnace, but instead of using heating elements consisting of fine wire coils wound on muffles, it uses less troublesome heavy molybdenum rod laid on ledges in the refractory brick. To produce these heating elements required molybdenum-to-molybdenum welds using atomic hydrogen, said to be its first application to large pieces of molybdenum.

Another research furnace of the same general dimensions and principle is expected to produce heats of 3400 F (2200 C).

A temperature of 4700 F (2600 C) is being sought in a still different, but much smaller furnace. In it a tungsten crucible, large enough to hold a walnut, is heated in an inert gas by a combination of radiant heat and high-frequency induction. Temperatures approaching 5000 F are really extreme. Tungsten itself begins to soften at about 4900 F. Iron melts at

2795 F; lava spews out of a volcano at 2200 F. If research men must have higher temperatures they will be indeed hard put to find materials with which to make them or to take them. But it can be counted that research will require higher temperatures and that they will be forthcoming.

It is pointed out that the furnaces were built primarily for laboratory use. Commercial production is not planned for the near future.

Atomic-Energy Exhibit

TO provide the American people with a citizen's understanding of nuclear-science developments, public education in atomic energy was urged with the opening of an atomic-energy exhibit at the American Museum of Natural History, New York, N. Y., on January 21, 1948. The exhibit will be open to the public at the Museum through April 5, 1948. It is the largest of its kind in the country, and is the first comprehensive educational exhibit developed under the auspices of the Atomic Energy Commission. The exhibit is sponsored by Brookhaven National Laboratory of Upton, N. Y., the center for basic nuclear research in the Northeast operated by Associated Universities, Inc.

Following its New York engagement, the exhibit will be displayed in other cities in the Northeastern and Middle Atlantic States. Designed for general public understanding, the exhibit is expected by its sponsors to provide the centerpiece for numerous community and group forums and discussions on nuclear energy.

Features of the exhibit include a model atomic pile which splits single uranium atoms before the eyes of the spectators. Energy released by this fission process is amplified into striking visual and sound effects A tiny capsule of a mixture of radium and beryllium, valued at $12,500, is used in the model to produce the neutrons that pierce the nuclei of uranium atoms in the fission chamber. This model was conceived by Dr. John R. Dunning, scientific director of Columbia University. Fig. 2 shows model of the atomic pile on display.

A model power plant shows how a nuclear reactor, or atomic pile, may someday be employed to generate electric power by means of the great heat release resulting from nuclear fission—heat that may be transformed into steam to drive electric-generating machinery.

Several demonstrations, models, and talks depict the great values of nuclear energy in scientific research and processes relating to the fields of medicine and biology, chemistry, agriculture, metallurgy, and numerous others.

There is the radioactive flower, growing in soil fertilized by a phosphate containing radioactive phosphorus. A Geiger counter is used to demonstrate the course of the "tracer" atoms into the roots, stem, leaves, and flowers of the plant. Scientists are employing radioactive substances produced in nuclear-energy processes to study life processes in far greater detail than ever before possible. See Fig. 3.

A large silhouette figure called "Mr. Atom" is equipped with a digestive system made up of a series of electric lights. The glow of the lights shows how radioactive substances may be followed through the human system by doctors diagnosing and treating human ills.

A miniature Van de Graaff electrostatic generator, a machine that builds up high charges of static electricity, is one of the several scientific instruments demonstrated in the exhibit.

A Wilson cloud chamber shows the paths made by atomic particles in a pressure chamber containing an atmosphere of fog.

To enable the public to visualize the make-up of the atom and its nucleus, or heart, the exhibit includes a section on "basic physics" that employs models magnifying by many million times the actual sizes of electrons, protons, neutrons, and other "building blocks." This part analyzes the simplest atoms, and goes on to explain radioactivity and why the nuclei of the heavy elements such as uranium are used in fission processes.

Photomurals and displays present the history of atomic development, and further explain the beneficial uses in prospect through the national program of research and development. A sample of Trinitite, the fused desert sand from the site of the test explosion of the first atomic bomb in New Mexico, is shown to be still radioactive by a Geiger counter.

FIG. 2 ATOMIC-PILE MODEL

(Actual breakup of single atoms of uranium takes place before the eyes of spectators at atomic-science exhibit. This model of an atomic pile marks the breakup of uranium atoms with visual and sound effects.)

FIG. 3 RADIOACTIVE FLOWER

(Tracer atoms, the radioactive substances used by scientists to study life processes, are demonstrated by this small shrub, growing in soil containing a phosphate fertilizer to which radioactive phosphorus was added.)

The Brookhaven National Laboratory and other nuclear research and development centers are described in special displays in their relationship to the many activities in the nuclear field now in progress in the United States.

Air Conditioning

AIR conditioning, both for comfort and for control of industrial processes, is expected to grow, for the market is far short of saturation in either field. According to the *Industrial Bulletin* of Arthur D. Little, Inc., for November, 1947, the industry expects to sell one billion dollars' worth of equipment in the next five years.

It is pointed out that although the human body has a better temperature-regulating mechanism than do many animals, it can still endure only a relatively narrow temperature range. The highest tolerable temperature for a clothed person in good health is only about 88 F in air saturated with water vapor, and about 138 F in dry air. But for maximum comfort and efficiency over extended periods, temperatures in the 70's, 60's, or even the 50's, depending on the humidity and the individual's physical activity, must prevail. Installation of an air-conditioning system in industrial plants increases worker efficiency and sometimes improves product quality. Because the air generally is filtered as well as cooled, reactions to allergies, such as hay fever, caused by air-borne dusts and pollens, is sharply reduced during working hours. Whether colds and respiratory diseases, in general, are significantly reduced is, however, still a question. Large reductions in absenteeism and a general increase in output are reported.

A recent survey disclosed that there are more than 2200 air-conditioned theaters in this country, but there are still 15,000 theaters without it. Over 1000 department stores are air conditioned, with installations that average more than 100 hp, but almost three fourths of the country's department stores still lack this facility. Although about 6500 restaurants are already air conditioned, this is a leading field for further installations, even though the average unit is rather small. Another large potential market lies in hotels, few of which are as yet completely air conditioned, and in banks and hospitals, which have only recently begun to use air conditioning.

The growing popularity of the heat pump is expected to increase the number of home air-conditioning units. The pump, a refrigeratorlike mechanism which draws heat from outdoors for winter heating, may be reversed in summer to pump heat out of the house. The convenience of one automatic device for year-round comfort makes it especially attractive for climates where the need for both heating and cooling is balanced.

While the first modern railroad car was not air conditioned until 1930, and air conditioning for comfort did not become common until the 1920's, the pioneer installations were made to solve production problems. A New York lithographic plant installed a system early in the century, and apparatus for cooling, dehumidifying, and circulating air went into a Boston chocolate factory in 1906 (and is still in operation). Many textile-manufacturing operations need controlled conditions of humidity and temperature. In making penicillin, air conditioning and refrigeration are prominent, for the mold gives maximum output when held successively under a number of rigorously regulated environments. Because many modern metal parts, ranging from ball bearings to marine-propulsion gears, require high precision, the expansions and contractions following normal temperature changes often exceed permitted tolerances. More machining and assembly operations are therefore being done in air-conditioned areas. Cutting down the dust content of the air prevents marring of surfaces in many plating, painting, and finishing operations. Air conditioning also reduces the annoying corrosion spots that sometimes follow when sweaty hands and fingers touch clean metal surfaces.

"Controlled weather" logically accompanies the substantially windowless plant that originated in the 1930's and was a typical form of construction during the war. The continuous walls and roof are slightly cheaper to erect than the conventional types and are tight against the multitude of small leaks in windowed buildings. Windowless buildings are thus both easier to air-condition and to heat. The heat given off by the lighting system, machinery, and the occupants sometimes suffices to keep the indoor temperature at comfortable levels when it is near zero outside.

As air conditioning becomes more common, the problems of many local water supplies are complicated. The equipment needs considerable quantities of cooling water, with the maximum demand coming during the hottest summer months when other water requirements are at their peak. Disposal is also a problem, for the capacity of many sewer systems may be exceeded, particularly after a heavy rainfall. Regulation of water supply and disposal by city ordinance is therefore common. In New York City, for example, large air-conditioning systems must cool and re-use the water in some way, e.g., by installation of an evaporative condenser or spray tower. On the western end of Long Island, perhaps the outstanding instance of industrial and municipal dependence on ground-water supplies, more than 200 recharge wells return water to the water-bearing strata. Since the returned water is warmer than the original ground-water supply, the local supply may in time become too warm for cooling purposes. At Louisville, Ky., another area of heavy dependence on wells, cold river water is pumped into the ground during the winter, to be drawn on in summer when the river water is too warm to be used economically.

New Automatic Pilot

FOLLOWING two years of study, experiment, and research, a new automatic pilot has now reached the production stage, according to a recent news letter from The Society of British Aircraft Constructors, Ltd. It is designed primarily for airplanes not exceeding an all-up weight of 15,000 lb, weighs only $17^1/_2$ lb, and is known as the Sperry "Pilot Aid." It works on the pneumatic electric principle and consists of five separate but interconnected units.

If a directional gyro is already fitted to the airplane and is modified to be incorporated with the Pilot Aid, the extra weight is only 13 lb 8 oz. The makers claim that, even including the weight of the directional gyro, the Pilot Aid is the lightest automatic pilot yet marketed in any country.

Many hours of test flying, mostly in an Avro Anson, have proved the soundness of the theories behind the new instrument, as well as the effectiveness of their technical interpretation. A demonstration given in the least favorable conditions at an airport near London offered convincing testimony that the Pilot Aid has been brought to a high state of efficiency.

The pilot's control unit includes devices enabling the pilot to apply banked turns, or to climb and dive within the limits of 20 deg roll and plus-or-minus 10 deg pitch, and to vary the "stiffness" of the control to suit rough or smooth air conditions. This unit need not be located in one particular place or even given a permanent site. If preferred, it can be fitted to a wandering lead and stowed in some convenient spot when not in use.

Almost equally flexible in their positioning are the other units; they can be disposed to suit the design of the airplane

or to conform to the wishes of the pilot. All are extremely compact and the largest—the gyro relay unit—measures only 7 in. × 6 in. × 9 in.

Because the gyros are spinning at all times during flight, immediate engagement of the automatic pilot is made possible. The response is instantaneous when the electric power is switched on, and just as quick when it is switched off. Switching off breaks the electric circuit and causes a magnetically closed valve in the pneumatic system to open. This allows the air to discharge into the atmosphere instead of passing through the servo-operating valves. Should circumstances require the automatic pilot to be overpowered instead of switched off, this can be done with little muscular effort.

In normal straight flying, the directional gyro gives a zero reading. Turns to an exact number of degrees (port or starboard) can be made by offsetting the directional gyro card from zero to the required extent and uncaging; the airplane then turns on to the new heading and settles down to straight flying again when the directional-gyro card reaches zero compass heading.

The new instrument is British in design and manufacture, and its makers are now engaged in research and experiment with the object of producing another lightweight Pilot Aid, this time operating on the electric-hydraulic principle, and suitable for airplanes of all sizes, but of particular application to long-range fighters and ship-borne aircraft.

Heat-Pump Economics

THE economics of the heat pump favor commercial as compared with residential installations for the next few years, according to W. E. Johnson, member ASME, manager, engineering division, General Electric Company. He spoke on the economical and technical aspects of the heat pump at the annual meeting of the American Society of Heating and Ventilating Engineers held in New York, N. Y., February 1 to 5, 1948.

In his study Mr. Johnson concluded that for year-round air conditioning in the home the most favorable market for the heat pump will be found in the more southerly part of the United States where the design heating requirements are about equal to the design cooling requirements, and where the home owner is able and willing to pay for summer air conditioning as well as heating. This places the market for the heat pump in houses in the field of higher-priced homes.

He said that commercial applications were favored because of the higher internal heat gain in this type of application as compared with houses. This heat gain, from human beings, lights, motors, other sources, tends to reduce the winter heating load and increases the summer cooling load, thus giving a more desirable balance between the loads and the two seasons.

An analysis of a typical case showed that the individual cost of the heat pump is determined by the summer and winter loads down to a 40-F winter design temperature. Below this the cost of equipment is determined by the summer cooling load. However, in a commercial building where there is sufficient internal heat given to maintain a 15-F temperature difference, the loads become equalized at 12 F instead of 40 F. Consequently, commercial applications will be economically feasible much farther north than will house installations.

He stated further that the heat pump is competitive in moderate design temperature regions where the cost of electrical energy is one cent per kilowatthour or less. An indication of the operating cost based on two commercial and one residential installations is that the power consumed ranges from $^1/_2$ to $^2/_3$ kwhr per deg day per installed hp of the compressor.

This analysis showed that the heat pump also has possibilities in the industrial field. It has not been used in industry in this country prior to this time because fuels are cheap, whereas in Switzerland it is rather extensively used because fuel is expensive and water power cheap and plentiful. A situation somewhat similar to Switzerland is found in western and northwestern sections of the United States where water power is plentiful and coal expensive.

Mr. Johnson cited one industrial process as being ideal for the application of the heat pump, namely, the concentration of solutions such as milk, fruit juices, and syrup. This can be accomplished by any of three methods: multistage evaporation, direct compression of vapor, and indirect compression. With a four-stage evaporation system, for example, he showed that three pounds of steam can be evaporated for one pound of steam used, with resultant important savings.

Rubber Research

IN an address delivered before the American Council of Commercial Laboratories, Washington, D. C., recently, Dr. E. U. Condon, director, National Bureau of Standards, pointed out that one of the fields vital to our economy, in which we have been dependent on European research, is rubber. The need for synthetic rubber during the war, as a result of the unavailability of natural rubber, is well known. What is not so well known, he stated, is that the synthetic rubbers we used were developed largely by the Germans. The four types of synthetic rubber which we produced during the war were GR-S, Neoprene, Butyl, and the Nitrile rubbers. Of these only Neoprene is purely American, a development of the du Pont Company. Butyl is partially an American development, for it constitutes a radical improvement of the German material polyisobutylene, yet it was based on this German work. Fundamental patents were taken by the Germans on the remaining two types—the Nitriles (under the German name Buna-N) and GR-S (under the German name Buna-S)—in the early 1930's. Of all these rubbers, GR-S is the most important: more than 80 per cent of our total production was of this type because it is not only cheaper but best for tires.

Dr. Condon said that, now that natural rubbers are again available, the problem of what to do with the synthetic industry, which involved a federal investment of more than $700,000,000, is acute. This industry will be called on for only limited production, primarily to insure plant potentialities in the event of any future emergency and to provide the synthetic product for certain applications. The magnitude of the investment, the size and scope of the plants, and the relations between the synthetic and natural commodity are major commercial problems. For this very reason the need for continued research and development is obscured.

He revealed that the National Bureau of Standards has long been active in the research and development phases, both as they pertain to synthetic rubbers and natural rubbers. From the standpoint of the national economy and security, it is necessary that a major and co-ordinated program of research and development be maintained in this field. Basic research is necessary if new types of synthetic rubbers are to be developed; developmental research is needed to develop desirable characteristics in the rubbers now available, to determine their properties. Much also remains to be done in measurements and instrumentation associated with the synthetic rubbers.

In the future, he said, this country must have a vigorous program of rubber research to maintain "a technologically advanced and rapidly expansible domestic rubber-producing industry" as part of our national policy outlined in the Crawford Act (Public Law 24, 80th Congress.) The cost of such a

program would involve an annual expenditure of about 4 million dollars, which is less than 1 per cent of the amount spent for the 1 million tons of rubber that this country consumes annually. Industry should expend a corresponding amount for the development of new rubbers, in addition to its expenditures for research on end-products.

Dr. Condon pointed out that the cost of such a program is really relatively small in terms of the value of the commodity and in terms of its national importance. Merely to maintain the present synthetic plants in a stand-by condition involves an annual expenditure of more than 8 million dollars, and these plants may well be obsolete at the time of another emergency; so that a federal expenditure of half this, to insure our future in this field, is, from any practical point of view, trifling.

Deep-Well Camera

AN improved deep-well camera for photographing the rock formation or the casing in deep wells was described by O. E. Barstow, Dow Chemical Company, and C. M. Bryant, Dowell, Inc., at the 1947 ASME Spring Meeting, Tulsa, Okla.

DESCRIPTION

As shown in Fig. 4, the apparatus consists of two main parts: a camera chamber and a water chamber. The camera chamber contains air at atmospheric pressure and houses the camera, including lens, film, and film-drive mechanism. It must be strong enough to withstand the external pressure of several thousand pounds per square inch encountered in deep wells.

The water chamber, which is filled with clear water, is used merely to provide a path of clear liquid between the lens and the rock formation being photographed. The water chamber houses a light to illuminate the subject and an inclined mirror which permits the camera to view the wall of the well horizontally through the cylindrical picture windows in the side of the water chamber. The bellows shown in Fig. 4 serves to equalize the internal and external pressures on the water chamber so the picture window can be relatively large without encountering difficulties because of high pressure. In the bulkhead at the top of the water chamber is a pressure window immediately below the camera lens. This window must withstand full well pressure, but this is a relatively simple matter because the window diameter can be small.

Attached to the outside of the case is a spring which pushes

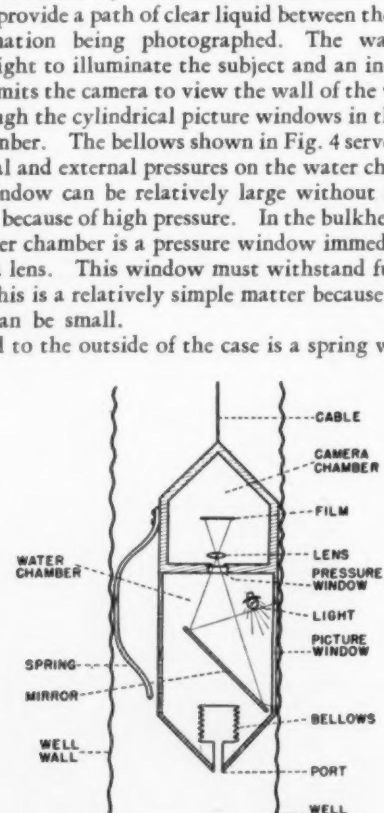


FIG. 4 SCHEMATIC VIEW SHOWING GENERAL PRINCIPLE OF OPERATION OF DEEP-WELL CAMERA

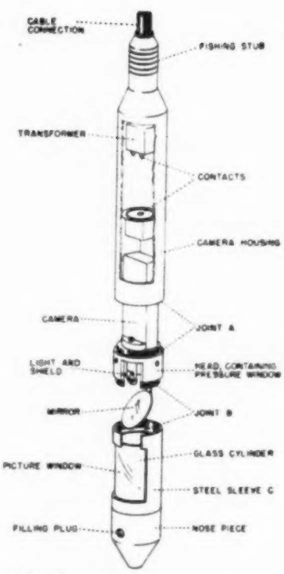


FIG. 5 (*Left*) CUT AWAY SKETCH OF DEEP-WELL CAMERA SHOWING GENERAL CONSTRUCTION AND ARRANGEMENT OF PARTS

FIG. 6 (*Right*) PHOTOGRAPH OF THE DEEP-WELL CAMERA ASSEMBLED AND READY TO GO INTO A WELL

the picture window against the well wall thus minimizing the thickness of turbid well fluid through which the picture must be taken. This spring also assists in keeping the camera stationary during exposures. By pushing the picture window against the formation, satisfactory pictures have actually been made in water so turbid that a sample of it in a pint milk bottle completely obscured any vision through the bottle. It is, however, always an advantage to have the well fluid as clear as possible. This is particularly true where there may be difficulty having the camera fit up tight against the formation or where the well wall may be rough and irregular.

The diameter of the water chamber is of course limited by the diameter of the smallest well in which the apparatus is to be used. Making the water chamber large is an advantage because this provides a large picture window and increases the area of the well wall which is photographed. Also, the greater the diameter of the cylindrical picture window the better it will fit up against the rock, thereby improving the pictures in case the well fluid is turbid. Making the water chamber fairly long is also an advantage, since this increases the distance from lens to subject, thereby increasing the depth of field. This facilitates sharp focusing even when the well wall is irregular with various parts of the formation at different distances from the picture window.

The camera itself is a revamped Bell and Howell Model 151 magazine-loading 16-mm movie camera with a 7.4-mm × 10.3-mm frame size. This camera has a built-in feature permitting it to take single exposures like any still camera. The control button has been coupled to a solenoid for remote electrical control. The power for driving the film still comes from the camera's spring motor which will give 450 exposures on one winding. A 15-mm-focal-length lens is used and provision has been made for stopping the lens down as small as f/32 if desired for greater depth of field. At f/32 an exposure time of 8 sec is satisfactory when using Eastman negative panchromatic safety film.

The lights are located to give satisfactory illumination of the

subject without undesirable reflections from window and mirror, are shielded from the camera lens, and are able to withstand the well pressure.

Figs. 5 and 6 show the actual construction of one of these cameras.

USE

After the well-bore conditions have been determined and corrected if necessary, the camera is loaded with film and attached to an electric cable which serves to transmit the power required by the apparatus and to provide remote control of the camera from the surface. Each roll of film is identified by taking a photograph of a card containing the roll number, date, well name, and other pertinent data. This is done before the camera is lowered into the well and serves also as a check on the electric circuit and the operation of the camera and lights.

The camera is lowered into the well at a rate of approximately 50 fpm. When the camera reaches the section in the well which is to be photographed it is stopped and an exposure is made by operating the surface controls. The correct exposure time depends on the lens stop setting and the type of film being used, and generally amounts to a few seconds. With the present cameras, the exposure time is controlled from the truck by the length of time that voltage is applied to the cable. This can be done with a manually operated switch or with an automatic time switch.

Two types of picture surveys are made: A continuous-strip photograph of the well bore showing every inch of the formation, and a series of single-shot pictures spaced at intervals of one foot, five feet, or any other interval desired.

Fig. 7 is an example of a photograph taken in a well in western Texas. The formation is the San Andreas section of the Permian lime in the Hendricks Pool. Pictures were taken in this well at depths of from 2300 to 2725 ft. When the pictures were taken, the well fluid was within 200 ft of the top of the well.

NEW DEVELOPMENTS

In some gas wells, the collection of dust on the picture window during the descent of the camera may present a difficulty not encountered in liquid-filled wells. To overcome this difficulty a camera has been built with an extra steel sleeve which

FIG. 7 TYPICAL PHOTOGRAPH MADE WITH DEEP-WELL CAMERA

(A well-defined zone of porosity is shown. Several types of porosity are illustrated, including well-distributed fine openings, large pores probably formed by leaching, and at least one leached stylolitic zone. This plate was taken at a depth of 2717 ft.)

slides over the water chamber and camera housing covering the picture window. When the camera reaches the point in the well where pictures are to be taken, the sleeve is released electrically and slides down far enough to uncover the picture window. This device appears very workable but has not been field-tested.

A new compact camera has been built which is electrically driven, uses 35-mm film, and takes 500 pictures 24 mm $\times$ 36 mm with one loading. The new camera fits into the same $4^3/_{16}$-in-diam case as the 16-mm camera. It has not yet been field-tested.

High-Temperature Metal

AN extremely hard metal that is said to retain its strength and resistance to corrosion at high temperatures has been developed by Kennametal Inc. of Latrobe, Pa.

This is a special "cemented carbide" composition manufactured by processes similar to those employed in making the carbides now used widely for cutting tools and wear-resistant parts, but with unique properties.

Reports indicate that it withstands temperatures that rapidly destroy conventional carbides and the best cast alloys; resists thermal shock much better than ceramics; and has a specific gravity about one third that of tungsten carbide and two thirds that of steel.

Pieces of this composition, grade K138, are said to have been heated to 2100 F for 48 hr without loss of strength. Neither does it change appreciably when heated to 1800 F and quenched in water. Air cooling from the same high temperature leaves no effect other than initial discoloration of the surface.

Its unique properties suggest many practical uses. Resistance to oxidation and hot gases, together with abrasion resistance because of high hardness, make it suitable for high-temperature structures, such as furnace parts, and guides for hot-rolled metal. Its lightweight and strength are advantageous for rotating parts exposed to high temperatures.

This heat-resistant material consists essentially of titanium carbide with cobalt as the bonding element. The titanium carbide has heretofore been used only as a minor ingredient of cutting-tool alloys. The metal can be formed into a great variety of shapes and sizes, with tolerances and finishes common to conventional cemented carbides.

Industrial Hygiene

IN a talk which was delivered recently before the annual meeting of the Industrial Hygiene Foundation at the Mellon Institute, Pittsburgh, Pa., William B. Given, Jr., president, American Brake Shoe Company, said that "industrial hygiene has up to recently been years and years behind medicine. That distance has been greatly shortened. But we in industry are still lagging. The Industrial Hygiene Foundation is continually giving industry new tools to use in making plants and offices healthier places. Our job is to put them to use with high zeal.

"We need not only better working conditions but the best possible working conditions. Today, we have a new conception of what plants ought to be. Every part of every plant must be better lighted than even the expert says is necessary. Every possible safety hazard, irrespective of cost, must be eliminated. There must be cleanliness, good air, and the best temperature possible to maintain.

"There must be as little lifting and carrying as possible. There must be a decent wash and locker room, with ventilation so that men can shower and change clothes in comfort, and not

have to put on damp work clothes the next day. There must be a clean place to eat. As far is humanly and mechanically possible, our job is to give each man conditions we should like, were we working in his place. This is not only a human obligation; it is the only way we can gather into our working forces decent, competent young men—the only way we can successfully compete for them with other industries.

"If you 'rate' the best people, gradually you will get them. Management has always known the importance of right people. In the old days it went out and looked for them. In recent years we have realized that to get them we must earn the reputation of being 'a better place to work.' In the future no plant will rate the best people without a successful medical department.

"We must build our human relations on the basis of the debt a company owes the people who make its success.

"We know medical research can solve the occupational health problems. We in management must effectively put to work their successes."

The prerequisites which Mr. Given feels are "musts," if industry is to continue to improve working conditions and make medical and safety programs as effective as possible, are as follows:

1 The senior officers in companies must feel and accept personal responsibility for the effectiveness of their medical departments.

2 Industry must be willing to spend generously for better working conditions. Many companies are today hamstrung by budget controls which defer until a later date expenditures that are "musts" today.

3 Management must teach its operating people to practice better co-operation with medical departments.

4 Industry must be as willing to gamble on new safety "possibles" as it is to gamble on new production ideas.

5 We must see to it that those in charge of our medical departments understand the human elements involved. Once we have chosen the right kind of medical boss, he must have the effective backing of company officers. Many an able medical head is wasted in companies where company officers have the right "patter" and the wrong hearts.

Nailing Techniques

THE "Technique of House Nailing" a new 54-page illustrated publication dealing with one of the oldest and most basic phases of the homebuilding process, has been announced recently by Housing and Home Finance Agency, Washington, D. C.

The study was prepared by the Forest Products Laboratory at Madison, Wis., a part of the Forest Service in the U. S. Department of Agriculture, in collaboration with the Technical Staff of the HHFA.

The booklet contains more than 50 illustrations of correct nailing techniques covering practically everything from double sills and drop-siding to subflooring and shingling, together with the size of nails to be used. For example, a three-piece girder should be nailed from each side with 20-penny nails, two near each end of each piece, others staggered with a horizontal distance of 32 in. between nails, and bridging on joists should be nailed at each end with two 8-penny nails. The booklet shows the most economical use of nails for effective construction, a factor of particular importance at the present time when the nail supply is short in many areas.

The HHFA had the study reviewed before publication by an experienced carpenter to determine its practical usefulness to the man who does the nailing. The booklet is also welcomed by the Federal Housing Administration, which is interested in improved home-construction methods under its mortgage-insurance program, and by the Apprentice Training Service of the Department of Labor, which works with Apprentice Training Committees in a nation-wide program to meet the need for more trained construction workers.

No particular design of framing is favored in the booklet and nailing instructions are limited largely to structural details necessary for rigidity and strength, without any consideration as to the trim or other decorative parts.

Copies of "Technique of House Nailing" are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The sale price is 20 cents per copy.

Petroleum Pumper Activities

THE application of motion and time study techniques to pumper activities in petroleum-production operations were described by H. G. Thuesen, member ASME, head, industrial engineering, Oklahoma Agricultural and Mechanical College, Stillwater, Okla., at the 1947 ASME Spring Meeting, held in Tulsa, Okla.

It was pointed out that labor cost for pumper activities totals many millions of dollars annually. Extensive applications of job design in many widely scattered fields in the Southwest have resulted in labor cost reduction for pumper activities of from 25 to 50 per cent.

The pumper is a key worker in that a huge investment in wells and surface equipment is operated under his immediate direction. He does this with a minimum of detailed supervision because pumper jobs are decentralized. Perhaps, because of decentralization, supervision appears to focus much more attention upon the equipment in charge of the pumper than upon the essentials of the pumper's jobs and how the pumper performs them.

The essentials of a pumper's job are: (1) Detect trouble which will result in damage or loss of production and correct or report it to lease foreman; (2) service, adjust, and make minor repairs to equipment on the lease; (3) switch, top out, and gage tanks, report gages, and run oil to the pipe line; and (4) maintain the lease and lease equipment to the desired standard of cleanliness and orderliness.

To accomplish these objectives the pumper performs numerous and distinct tasks such as the following: (1) Walk from well No. 5 to well No. 6; (2) check operation of engine, pumping unit, and subsurface equipment; (3) service engine; (4) fill radiator water barrels; (5) test lead-line pressure; (6) fill chemical pump with chemical; (7) start engines that have died; (8) repack stuffing box; (9) grease pumping unit; (10) measure oil in stock tank; (11) switch stock tanks; (12) check status of receiving tank; (13) check with gager and sign run tickets; (14) change charges on pressure indicator meter; (15) make out daily gage reports; (16) requisition supplies and make out work and car allowance time sheets; (17) assemble equipment for use in servicing and operation equipment; (18) maintain appearance of lease; (19) lubricate Merco valve; and (20) lubricate O.C.S. Werme fronts.

The items of the job can be worked up in greater detail, for instance, item 3, service engine, involves the following: Manually and visually check oil in crankcase and add if necessary. Check water in radiator and add water if necessary. Make a visual check of oil, water, and ammeter gages. This must be done twice daily and the average time to do the job is 0.9 min per visit.

Item 12, checking status of receiving tank, involves manu-

ally running can on gage line to determine amount of water, bottom settlings, and sand in tank. This is done monthly and requires 2.40 min per tank.

The job of a single pumper may embrace fifty or more definable tasks such as the foregoing. In designing a pumper's job, tasks performed by the pumper, and the time required to perform each, are recorded as they are being performed by the job analyst who accompanies each pumper from one to four full days. For this purpose the job analyst uses a clip board equipped with a decimal timer which enables him to make a time record accurate to 0.01 min.

From this record the tasks performed by the pumper are classified and the analyst proceeds to design the job as follows:

1 *Travel.* Since travel is a large item in pumping routes to be traveled and the mode of conveyance—foot, car, or horse—are considered, wells are grouped, and routes are laid out on a map in order to arrive at the wells that should be handled by each pumper for greatest economy in travel. In a recent study this method resulted in reducing the aggregate travel from approximately 75 miles per day to 40 miles per day (see Figs. 8 and 9). At current rates of pay it costs about $0.45 for a pumper to walk a mile. This high cost suggests the need for careful consideration of travel.

2 *Regular Work.* The design for the regular work is built up by determining the regular tasks that are to be performed after each has been examined to insure that it is necessary and can be performed in the most effective manner. These are arranged in the order in which they are to be performed by the pumper with proper regard for route to be traveled, the time required for each task, and the frequency each task is to be performed. Careful analyses of economic factors often reveal that certain detailed tasks need not be done as frequently as has been the practice. In other cases it may prove economical to improve equipment so that servicing need be done less frequently. For example, the addition of automatic oilers may change a daily task to a monthly task. Examination often reveals that some tasks can be more economically performed by special crews with special equipment. Clean up location and change engine oil are examples of such tasks.

3 *Irregular Work.* Allowances are made in the pumper's schedule for tasks that do not occur with predetermined regularity. This allowance is determined from the observed time required to perform these and the average frequency with which they occur.

4 *Nonproductive Time.* Nonproductive time is eliminated in so far as possible by better planning, organization, instruction of the pumper, and changes in equipment. An example of the latter is the installation of equalizing lines to eliminate nonproductive time in topping tanks. The allowance for nonproductive time is determined on the basis of the observed times for this item.

5 *Personal Time.* This item is difficult to determine since the human element is involved. An allowance for the more concrete items in this category, such as rest for overcoming fatigue, time for personal needs, time for changing clothing, cooling off, or warming up, can be determined fairly satisfactorily. How much the allowance should go beyond the time required for the more essential personal needs is a matter of judgment.

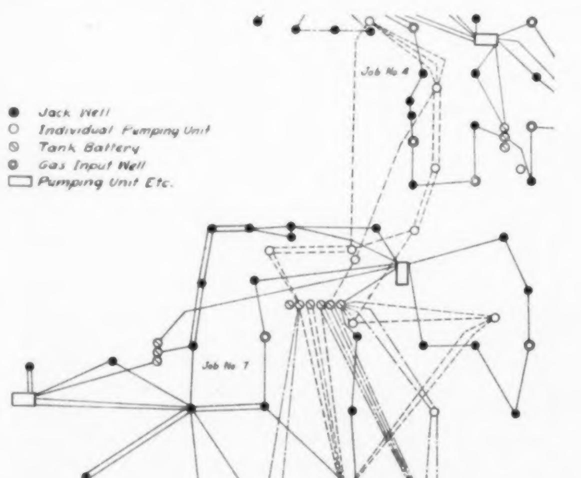


FIG. 8 DAILY ROUTES OF PUMPERS IN A SECTION OF AN OIL FIELD PRIOR TO JOB ANALYSIS

FIG. 9 DAILY ROUTES OF PUMPERS IN OIL FIELD SHOWN IN FIG. 2 AFTER JOB DESIGN

Job design requires careful observation and analysis and the patience to think through each detail with meticulous care and due consideration for the practical and human factors involved. A job properly designed can be delineated in a written specification which describes each step of the job so clearly that it can be followed by anyone familiar with the type of work involved.

Mold Research

THE steel division research committee of American Foundrymen's Association will sponsor a study of the influence of mold conditions on the development of hot tears in steel castings, it was announced recently.

Confined to an investigation of factors within the mold itself, the research, under exacting laboratory conditions, is expected to determine which factors contribute to the development of the defect and to what extent, and to indicate suitable methods for the control of hot tearing in production operations. Also involved in the project is the design of a pattern to serve as a measure of the tear susceptibility of various steels.

Among mold factors to be studied in the project are mold collapsibility, sand-grain size, moisture content, hot strength, mold hardness, and binder content. The relationship of each to the occurrence of hot tears will be established. A standard melting procedure and rigid control techniques will be used to obtain metal of uniform analysis and pouring temperature for all tests.

Atomic Energy and Medicine

THE practice of medicine is certain to be affected by the increasing knowledge of subatomic chemistry, according to a pamphlet "The Medical Significance of Developments in Atomic Energy," prepared by the Council on Physical Medicine of the American Medical Association. It is stated that however rash it may be to speculate on the coming developments it is advisable to picture them somehow and to prepare for them as best one can.

Many of these developments will proceed in unexpected directions and will affect daily life in unexpected ways. But it is safe to say that the work of the physician will be affected by important discoveries in the following fields: diagnosis, treatment, and occupational disease.

New diagnostic methods will be developed, especially in the form of functional tests. Atoms of radiophosphorus act chemically and physiologically just like atoms of ordinary phosphorus, and can lodge as phosphates in teeth and bones; but they betray themselves wherever they are concentrated by the fact that within any given time interval some of the radioactive atoms must disintegrate. Each disintegration involves the emission of either particulate or undulatory radiation, commonly both, and can be detected by instruments. Similar statements can be made for radioactive isotopes of carbon, of iodine, and some other elements. Out of this fact alone may come new diagnostic functional tests—tests for circulation, secretion, metabolism, excretion, and the like. There is not only the possibility of diagnosing the presence of concretions and neoplasms, but even of distinguishing among various kinds. New types of radiation may supplement the roentgen rays among diagnostic methods.

New therapeutic methods are certain to develop and it is far from idle to speculate upon their nature. New types of radiations will become available—undulatory radiations differing in wave length and intensity from those now in use, and particulate radiations, charged or uncharged, differing in type and speed from those available at present. Some of these may have special effects on diseased tissue, and may supplement radium and the roentgen ray. The possibilities in physical medicine are great, but so are those in chemotherapy. Every newly purified isotope, whether radioactive or not, multiplies the number of chemical compounds that will need to be prepared by laboratory workers, tested on laboratory animals, and submitted for therapeutic trials.

Finally, the physician will have to be prepared to deal with unfamiliar syndromes among people exposed in various ways to the new radiations and new substances. They may occur among miners and metallurgists, among chemical engineers and laboratory investigators, among plumbers, janitors, and others who unwittingly linger in buildings where radioactive wastes have settled in sinks and sewers, among animals and plants that happen to absorb such materials, and, finally, among victims of future bombs. (It is earnestly hoped of course that all of these misfortunes will be prevented.)

Low-Pressure Wind Tunnel

SOME of the design studies made for a small, nonreturn, low-pressure, supersonic wind tunnel were presented by R. G. Folsom, professor, and E. D. Kane, assistant professor, both of the University of California, Berkeley, Calif., at the 1947 Aviation Meeting of ASME, held in Los Angeles, Calif. Professors Folson and Kane are both members of ASME.

They pointed out that as the speed of aircraft becomes larger, the importance of operation at high altitudes increases. At the present time considerable valuable but uncontrolled experimental data are being collected from the instruments installed on the V-2 rockets being fired in New Mexico. These data are of importance for determination of the physical characteristics of the upper atmosphere, and the fluid flow and heat transfer associated with the flight of the rocket, but the cost of such experimentation is high. Preliminary studies have indicated that important fundamental information regarding fluid flow and heat transfer at low pressures (corresponding to high altitudes) may be obtained economically from laboratory equipment, including low-pressure wind tunnels.

As one illustration, a tunnel with a 4-in. × 4-in. test section and capable of free tunnel Mach numbers up to about 4 has been selected. These are the basic specifications of a wind tunnel designed by the National Advisory Committee for Aeronautics in co-operation with the Office of Naval Research as part of a compressible-flow laboratory unit suitable for research and instruction at educational institutions. In its original form, this proposal provides for intermittent operation from a compressed-air supply with exhaust at atmospheric pressure. An-

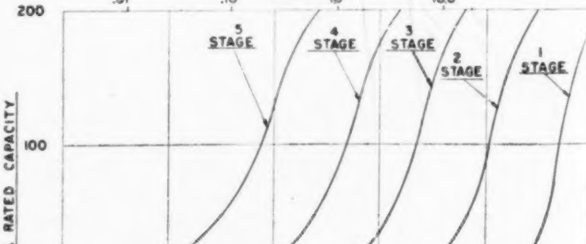


FIG. 10 PERFORMANCE OF STEAM EJECTORS

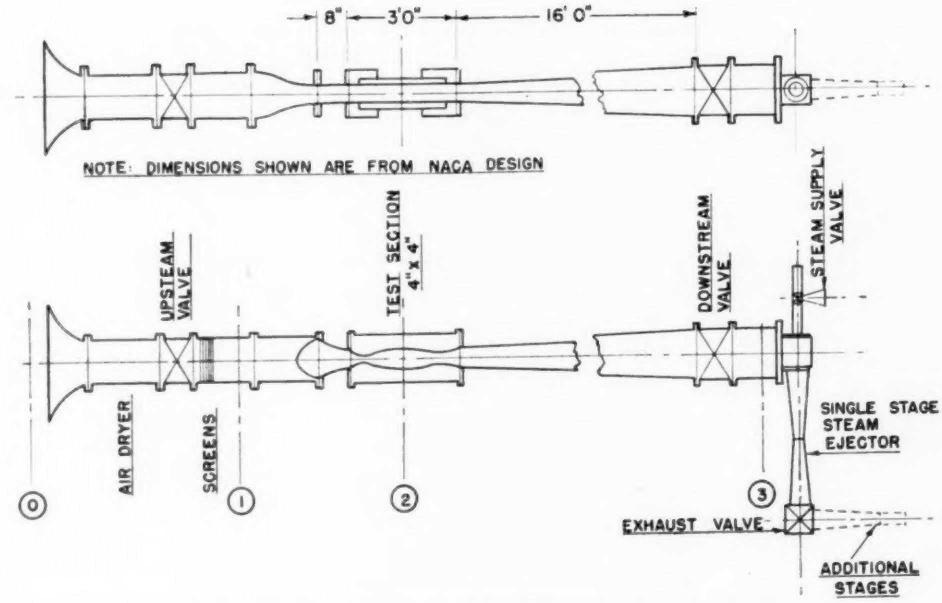


FIG. 11 SCHEMATIC DRAWING OF JET-DRIVEN SUPERSONIC TUNNEL

other illustration deals with a wind tunnel for testing in the intermediate vacuum range. Steam-ejector drive systems are considered for each tunnel.

Flow experiments with equipment of small size are frequently limited in value due to effects of low Reynolds numbers. In the case of tests at supersonic velocities and low pressures where the molecular mean free path may be of the same order of magnitude as a characteristic linear dimension, many unknown factors enter the problem. A small wind tunnel is said to provide a possible means of studying flow phenomena when slip at solid boundaries becomes appreciable. It should be noted that the wind tunnel is only one class of equipment that is capable of significant results in this field of low-pressure investigation.

The characteristics of a steam-jet drive were investigated since the required tunnel pressures fall within the operating range of this type of equipment. The steam-jet air pump consists essentially of a steam nozzle, converging and mixing tube, and a diffuser. High-pressure steam is supplied to the nozzle through which expansion takes place and steam velocities reach about 3000 fps at exit from the nozzle. The high-speed steam jet entrains air by a process not clearly understood and the mixture flows into the mixing tube and then into the diffuser, the latter converting as much as possible of the kinetic energy of the mixture into pressure. Multistage equipment routes the air being pumped through several jets connected in series. To increase performance interstage condensers are frequently used to reduce load on the higher pressure stages. The general range of performance of steam-jet air ejectors of commercial manufacture and different numbers of stages is presented in Fig. 10. The actual air capacity is regulated by the size of the unit selected. Jet pumps are not efficient but are reported to find many applications due to low first cost, simplicity, convenience in operation, or other reasons which overbalance the poor operating performance.

A typical arrangement for a steam-jet drive of a nonreturn wind tunnel is illustrated in Fig. 11. Conditions at the test section may be regulated through manipulation of one or more of the flow control valves shown. Although some economy in operation may be realized by throttling the drive steam through partially closing the steam-supply valve, a reduction in the steam pressure at jet intake could readily cause the operating point of the pump to shift into an unstable operation region. Control by partial closing of the discharge valve from the ejector is undesirable also from the standpoint of stability. In this treatment the ejector valves will remain wide open and control will be limited to that possible by adjustments of the upstream and downstream valves, the setting of either affecting the demand curve. By changing the adjustment, the intersection (operating point) of the pump characteristic and demand curves may be altered to produce the desired flow characteristics at the tunnel test section.

In order to investigate some of the flow problems on a convenient small scale and to gain experience in operation of a steam-driven low-pressure wind tunnel, a model, nonreturn, supersonic, low-pressure wind tunnel has been installed in the laboratory where sufficient steam capacity for continuous operation is available. Preliminary results have demonstrated the flexibility and ease of control, the necessary care in mechanical design required for vacuum installations, and the importance of laminar boundary-layer phenomena at low pressures. The model tunnel will be used in the development of procedures for flow visualization at low test pressures. This unit has a Mach number of about 2.4 and a test section 1 in. × $^3/_8$ in.

The authors stated that the steam ejector is a suitable method for the drive of a small-scale supersonic wind tunnel with low pressures in the test section. When steam-generating capacity is available for continuous or intermittent operation, the ejector drive system may be economical for use by educational institutions or industrial companies.

Synchrocyclotron

THE Carnegie Institute of Technology will construct its new synchrocyclotron at Saxonburg, Pa., 28 miles northeast of Pittsburgh, Pa., it was announced recently by Dr. Robert E. Doherty, Fellow ASME, president of the Institute.

Although it was planned to build the cyclotron on the Carnegie Tech campus, school officials said they had decided to change the location to a site which would allow more room for expansion of nuclear-research facilities in the future, should the need arise.

According to Dr. Edward C. Creutz, associate professor of physics at Carnegie Tech, and administrator of the project, the cyclotron should be in operation early in 1950, if deliveries of materials and equipment are received on schedule.

Total cost of the entire project, including the building, will be in the neighborhood of one million dollars.

The new synchrocyclotron is expected to produce 350 million electron volts instead of 250 million as originally announced. The step-up in energy-producing capacity of the atom smasher

will largely be due to improvements in design of its proposed 1000-ton electromagnet, the result of one and one half years of research by Carnegie physicists.

Experimenting with $^1/_{14}$-scale working models, Dr. Creutz and his associates have succeeded in evolving a magnet design which will produce $^7/_8$ of the proton energy of the largest cyclotrons now under construction, while using about one half of the steel and requiring only 60 per cent of the electric power needed to operate the largest machines.

A further improvement in the new cyclotron will be the high-frequency oscillator, radically different from those used in other atom smashers. The oscillator will furnish the high-frequency power used to accelerate protons (subnuclear particles) in the flat D-shaped chamber of the cyclotron. It is reported that this oscillator will require less power, and will produce a higher voltage in the "D," than other models in use.

Dr. Creutz said that there was good reason to believe some of the most baffling mysteries in the properties of matter may be solved through the use of the high-energy cyclotrons now being built in this country. These discoveries probably will revolutionize science and its applications, hence the importance of continuing high-energy research.

New Synthetic Rubber

A NEW synthetic rubber which may equal or surpass natural rubber in tire treads was described recently by John P. Coe, vice-president and general manager of United States Rubber Company's synthetic rubber division, at a symposium on "The National Rubber Situation," sponsored by the Chemical Engineer's Club of Washington, D. C.

Mr. Coe reported that preliminary data have indicated tire-tread quality substantially improved over anything achieved heretofore with natural rubber. He added that even the most conservative chemical engineers rate the new rubber as "at least equal to natural, according to preliminary data."

He stated that the secret of this improvement in man-made rubber is a sharp reduction in temperature of the chemical reaction by which the GR-S is produced from butadiene and styrene. The new rubber is made at the frigid temperatures between zero and 40 F instead of at the customary 125 F.

Powder Metallurgy

ADVANCES in the science of powder metallurgy have long been hindered by the difficulty of obtaining reproducible results in large-scale manufacture. This is due principally to present methods and techniques which introduce numerous variables as yet not completely understood or controllable. In conjunction with the current program of standardization of test methods and techniques in this field, the National Bureau of Standards undertook an extensive investigation of the conditions contributing to the lack of reproducibility in sieve analysis of metal powders. Such analyses of particle-size distribution are of major importance in powder metallurgy.

Investigations at the Bureau revealed that atmospheric humidity has a marked effect on the results obtained by sieve analyses of metal powders and that controlled atmospheric conditions during sieve testing of metal powders may therefore be necessary when close control of particle size is desired. Increase in humidity tends to increase the weight of the fractions retained on the sieves and decrease the weight of the pan fraction. Differences of as much as 10 per cent between the weight of fractions of powdered iron sieved under high and low humidities have been observed.

In sieve tests of sponge iron, electrolytic iron, electrolytic copper, and nickel, made for the purpose of accumulating supplies of sieved fractions of these powders for other studies, it was found that reproducible results could be obtained only when certain variables were controlled. Significant differences in sieve analysis often were obtained when samples of the sieve powder were sieved at different times with the same sieves. Furthermore, different sets of certified sieves used for the same powder gave variations of considerable magnitude. A contributing factor, in addition to atmospheric humidity, was a cumulative sampling error that resulted from repeated riffle cutting of limited powder supplies.

Oxygen Determination

AN improved technique for the direct determination of oxygen in high-molecular-weight organic compounds has been developed by the National Bureau of Standards. By this method, small amounts of oxygen, such as occur in natural and synthetic rubbers, in plastics prepared from hydrocarbons, and in mineral oils, can be measured with precision and accuracy. Essential features of the procedure are thermal decomposition of the sample in an atmosphere of oxygen-free helium and conversion of the resulting oxygen compounds to carbon monoxide by passage of the products over carbon at 1120 C. The oxygen content of the material is then calculated from the percentage by volume of carbon monoxide in the collected gas as determined by the NBS carbon-monoxide indicator.

In recent years the need for a direct oxygen method has been especially pronounced in the fields of high-polymer plastics and synthetic rubber. Oxygen determination is important, for example, in studying the effects of various agents added to retard aging of rubber and in ascertaining the influence of small amounts of oxygen on the physical properties of this substance relative to processing and vulcanization, as well as in the basic study of the composition of the polymer. Likewise, in the analysis of synthetic rubber there is need for extremely close agreement among values obtained by various laboratories in order that rubber produced by different plants may be interchangeable.

The Bureau's apparatus consists primarily of a helium tank with pressure regulator, a furnace at 400 C packed with copper spirals through which the helium is passed to remove oxygen, a U-tube filled with ascarite and a drying agent to absorb carbon dioxide and moisture from the helium, a quartz tube having a section packed with carbon pellets, a tubular furnace enclosing that section of the quartz tube and heated to 1120 C, and a flask of accurately measured volume in which the carbon monoxide is collected.

The apparatus is arranged so that a continuous stream of helium is passed over the heated copper and through the drying agents into the quartz tube. After the weighed sample has been placed in the entrance end of the tube on a platinum boat, air is swept out of the system by means of a reverse stream of heated helium for two hours. The flow of helium is then directed forward through the high-temperature furnace toward the collecting flask.

The sample is burned by slowly advancing a Bunsen burner and a gauze mantle along the section of the quartz tube containing the platinum boat. This operation, requiring about 10 minutes, is repeated to insure complete decomposition of any particles that may have sublimed to other parts of the tube.

The products of pyrolysis pass with the helium over the hot carbon in the furnace and through a liquid-air trap to the collection flask, where water is gradually displaced by the mixture of gases. After a given volume of gas has been collected, as

measured by the water level in a capillary, the collecting flask is disconnected and a stopcock opened momentarily, allowing a small amount of air to flow into the flask to restore atmospheric pressure. To determine the percentage by volume of carbon monoxide in the collected gas, the flask is connected through a flowmeter to an NBS carbon-monoxide indicating tube, which contains a colorimetric indicating gel capable of detecting and estimating less than 1 part of carbon monoxide in 500 million parts of air. After the gas has passed through the tube at the rate of 70 ml per min for a definite period, the color shown by the indicating tube is compared visually with standard tubes prepared at the same time by passing known amounts of carbon monoxide through them. From the value obtained for the volume concentration of carbon monoxide in the collected gas, the volume of the gas (which is known by previous calibration of the flask), the density of carbon monoxide, and the weight of the sample, it is possible to calculate the percentage of oxygen in the material.

It is reported that this method has been used with excellent results at the Bureau in the analysis of compounds containing less than two per cent of oxygen, and it is expected that with some modification the procedure may be used in the analysis of materials containing higher percentages of the element.

Color Microscopy

MICROSCOPY in color, without the use of dyes or light filters, is a new microscopy technique developed by Germain C. Crossmon, Bausch and Lomb Optical Company, which is said to provide a speedier, more accurate identification of a wide range of colorless transparent substances, including drugs and minerals.

In a talk delivered recently before the Zoological Section of the American Association for the Advancement of Science, Mr. Crossmon termed the technique "dispersion staining" and showed color photographs of thin sections of body tissue in which muscle fiber, blood vessels, and fatty tissues appeared in bright contrasting colors.

He demonstrated that only standard microscope equipment is required to turn transparent colorless objects to bright colors. By choice of the correct immersion liquid which is placed over the sample, each different material appeared a different color. He further illustrated his technique with photographs of textile fibers, grains of glass, and mixtures of minerals. In each case, particles of different composition were different in color.

The apparent magic by which white light on a colorless object produces color has a sound scientific explanation, he pointed out. The light from the microscope lamp is passed through a dark-field substage lens to strike the sample at a high angle. The sample is covered with a high dispersion liquid that matches the light-bending ability of different materials in the sample at different portions of the color spectrum.

Each material then scatters some of the colors present in the white light into the microscope where they are seen by the observer while other colors pass directly through the sample at such a high angle that they do not enter the microscope.

The new method is expected to increase use of the microscope in checking foods or drugs for adulteration or contamination, testing minerals or ores for impurities, and textiles for fiber identification. Crime laboratories may try "dispersion staining" to decide if microscopic fragments of materials are identical or not. Its use is also foreseen in medical microscopy for studying the relative refractive index of body-tissue structures. Use of dyes to stain tissues or bacteria probably will not be supplanted in those cases where absorption of the dye is a specific chemical identification of the material.

In all of the many cases where a mixture of transparent materials is to be studied with a microscope, the color contrast produced by dispersion staining is expected to make the work of the microscopist less arduous.

Plastics Handbook

PUBLICATION of the Handbook of the Society of the Plastics Industry was announced recently at a press conference held in New York, N. Y. It is reported that the new handbook will make available to engineers in all phases of American industry a final source of standard information on plastics and the best practices of the plastics industry.

According to SPI spokesmen, until now those researching in materials and processes for possible uses of plastics in their products or plants have been forced to consult many technical works and carry on prolonged correspondence with companies in the plastics field.

The 451-page book has been in preparation four years, for it dates back to early 1942. At that time Army, Navy, and Air Corps officers who were checking best uses of plastics in aircraft and other service equipment, requested data from SPI which were then unavailable.

Three hundred technicians and other authorities from more than 600 firms worked on the book. Six chapters were released as preliminary booklets in the last 3 years but these have been revised for the final publication. The book will be revised as conditions warrant it.

Chapter headings of the book are as follows: Classification of Plastics Molding Materials; Molding and Forming Plastics Parts; Design of Molded Articles; Design Standards for Inserts—Their Application in Plastics Parts; Standards for Tolerances on Molded Plastics Parts; Cementing and Assembly of Plastics; Testing Plastics Parts; Mold Design and Recommended Steels; Machining and Finishing Plastics Parts; and Laminated Products and Their Fabrication.

There are more than 500 charts and illustrations in the book; 72 in the chapter on mold design.

Solar-Heat Accumulator

A PROVISIONAL experimental plant for the storage of solar heat has been erected in Switzerland, according to the December, 1947, issue of *The Engineers' Digest* (British edition).

Twenty six $1^1/_{16}$-in. pipes of 85-ft length are arranged at 4-in. center distance, giving a heating surface of 805 sq ft, below a double-glass roof for protection from wind and are insulated to prevent heat losses. A storage tank of 33-cu yd capacity is placed in a pit filled with dry earth and protected by a large roof against losses due to rain water and conduction through moist earth. During sunny periods, water is pumped from the tank into the heating-pipe system, heated, and fed back into the tank. The heat gained is used to supplement heat requirements of a central heating system. During sunless periods, the pump is stopped and the heating pipes drain automatically. The central heating system can then be served from the storage tank only.

The plant was used during the wet summer of 1946 and results showed that the water can be heated to boiling point. The theoretical maximum heating power was calculated as 2200 Btu per sq ft per day, but the highest figure actually reached was 800 Btu per sq ft per day (July); the monthly averages were 250 (March, August) and 420 (July). The highest water temperature of 148 F was reached in August. Average heat losses from the storage tank (580 sq ft surface) were 0.2 to 0.3

Btu per sq ft per deg F per hr, depending on the heat saturation of the earth surrounding the tank.

It is planned to add a double-tube counterflow heat exchanger and thus make the plant suitable for working all the year round and for bridging 10 to 12 sunless days. Pipe corrosion is to be prevented by automatic draining of the heating pipes during sunless periods and by filling with an inert gas under slightly increased pressure. Capital costs of the plant should be easily recoverable through saving of fuel and operating costs since a simple thermostat can insure fully automatic operation.

High-Pressure Locomotive Boiler

THE Steam Locomotive Research Institute, Inc., according to *Bituminous Coal Research*, October-December, 1947, is developing a locomotive boiler which, it is said, will permit satisfactory operation at pressures of 600 psi. The Institute is the research agency for The American Locomotive Works, The Baldwin Locomotive Works, and the Lima Locomotive Works. Its director of research is Lawford H. Fry, Fellow ASME.

The Stephenson locomotive boiler with its water-enclosed firebox and fire-tube barrel has inherent technical and mechanical advantages which have given it a practical monopoly in steam-locomotive practice. Its one constructional weakness has been the firebox with its flat walls supported by stay bolts. As pressures have gone up, stay bolts have come closer together, water circulation has been impeded, and maintenance costs have increased. At current boiler pressures the major part of locomotive-boiler maintenance cost is given to firebox repairs.

It is generally conceded that boiler pressures of 300 to 325 psi represent the practical maximum for staybolted fireboxes. From the prime-mover standpoint, higher pressures offer the advantage of greater power within the same space and also greater thermal efficiency. It is believed that a pressure of 600 psi could be used with advantage in American railroad practice, the prime mover being modified to take full advantage of the greater possible expansion. The conventional single-expansion cylinders would be replaced by uniflow multiple, expansion-turbine operation.

With the present trend to higher thermal efficiency it is definitely desirable to provide a locomotive boiler for higher steam pressures and with firebox maintenance minimized.

In view of stationary practice it is natural to think first of a water-tube type boiler. However, extensive comparative study by the Institute has shown that after the gases of combustion leave the firebox the intensive heat absorption required to produce a compact locomotive boiler can be obtained more efficiently with a fire-tube barrel than with any other tube arrangement. This conventional barrel does not limit the pressure and has the great advantage of being a strong structural element.

The advantages of a locomotive firebox with water-tube walls have long been recognized in America and Europe. Many designs have been made and a considerable number of boilers have been built. The advantages have been demonstrated but certain constructional troubles have developed. A recent survey of the situation by the Institute has led to the conclusion that many of the difficulties with earlier designs of water-tube fireboxes can be avoided by using modern methods of boiler construction as developed in stationary practice. Stationary boilers with water-tube fireboxes are built today for pressures up to 2500 psi. With modern methods and materials there should be no serious difficulty in building a locomotive boiler for 600 psi.

The design developed by the Steam Locomotive Research Institute follows closely the outline of a conventional locomotive boiler and can usually be built to fit an existing chassis if desired. Grate area, firebox, and combustion chamber are arranged as in a conventional boiler. No stay bolts are used. The firebox and combustion-chamber walls are closely spaced bifurcated tubes of the type used in high-pressure stationary boilers. These tubes terminate in a top drum or drums forming the roof of the firebox and in a smaller-diameter bottom drum.

In earlier locomotive water-tube fireboxes the tubes were rolled into the drums. This required a rather wide space between tubes and insulation was difficult. In the Institute design the use of bifurcated tubes welded into the top and bottom drums provides a practically continuous waterwall. It should be noted that the use of water-tube firebox walls reduces greatly the damage likely to occur in the case of low water.

The new boiler has not been built but is now under consideration by locomotive builders.

Fiberglas-Reinforced Plastics

VARIOUS resins have long been used in the formation of small articles in which the strengths inherent in the resin itself have been adequate. Subsequently, these resins were reinforced with papers, cotton fabrics, and various organic fibers. The introduction of glass fibers as a reinforcing material enormously broadened the range of sizes, strengths, shapes, and properties of products that could be molded and pressed from modern resins. One of the earliest developments embodied glass fibers in medium- to high-pressure resins using established techniques. The parts manufactured by this method were primarily employed for electrical applications and were largely limited to flat laminates.

Greatest progress, however, came with the development of new types of resins which would permit fabrication with relatively simple equipment involving comparatively low pressures (from atmospheric to 100 psi), low curing temperatures, and short curing cycles.

Various combinations of Fiberglas reinforcements with appropriate resins are said to give the industrial designer the following range of properties, sometimes singly, but more commonly in a combination of several: Strength-weight ratios (strength divided by density) in excess of those of any other known material including stainless steel, aluminum, and magnesium; impact resistance in excess of that of most metals; dimensional stability comparable with that of steel; directional control of strengths; resistance to propagation of cracks; weather resistance; temperature resistance; formability on molds of wood, aluminum, bronze, cast iron, mild steel, or other low-cost materials, in large irregular shapes limited only by the practical size of the molds or curing ovens or presses; low or contact pressure forming; and bow curing temperatures within the limitations of low-pressure steam or hot water.

These properties are said to be obtainable in usefully balanced relationship in all Fiberglas-reinforced plastics fabrications. Although neither maximum tensile strength nor minimum weight in relation to strength can be combined with maximum impact resistance, all these qualities are obtained to a high degree in all Fiberglas-reinforced plastics.

The manufacture of Fiberglas-reinforced plastics is simple. The fluid resins are combined with the reinforcing fabric or mat on the inside or on the surface of a mold made of low-cost, easily worked materials. In some cases the prepared mold is enclosed in a baglike envelope from which the air is exhausted to apply atmospheric pressures that hold the uncored, reinforced resin snugly to the mold. The whole unit is then placed in an oven operated at temperatures no greater than are used to bake a pie, and in a relatively short time (measured in minutes)

a completed product is ready for removal from the mold for trimming and finishing.

There are various other processes by which these operations are conducted, but basically all are the same. They require impregnation with the chosen resin, shaping on an appropriate mold, and the application of low pressures and heat. The equipment required to manufacture Fiberglas-reinforced plastic parts in reasonable quantities is a matter of low expense. Any pattern shop equipped to make wood, cast-metal molds, or hard-metal dies can produce the requisite forms. When contact-pressure resins are employed and low-unit production is anticipated, ordinary vacuum-pump equipment, a vacuum storage tank, and a set of bags made of impervious material provide all the pressure facilities required. In high-production types of operations using this type of resins, presses with a capacity of not more than 200 psi and capable of taking dies of the required size may be utilized. Generally these dies are heated by steam, oil, or water and eliminate the need for any oven equipment.

A new 36-page booklet containing up-to-date information on the properties of fiberglas-reinforced plastics, their range of applications, the economics of their manufacture and use, manufacturing methods, tables of properties of Fiberglas cloths and mats employed to reinforce plastics, 22 charts to help the designer make a preliminary selection of the type of Fiberglas reinforcement that will best meet his requirements, and covering applications and manufacturing methods, may be obtained without cost from Owens-Corning Fiberglas Corporation, Toledo 1, Ohio.

High-Voltage Electric Boiler

A THREE-PHASE 16,000-kw electric boiler with an evaporation of 22,000 kg per hr, was put into service in a large Swiss chemical works in July, 1946. This is said to be the largest electric boiler so far built in Switzerland and is described by A. Schmutz in *The Brown Boveri Review*, December, 1946. It is of the water-jet type and is connected directly to a 10-kv supply. Because of its large diameter (2300 mm) and relatively high pressure (26 kg per sq cm g), difficulties were encountered in obtaining the necessary material for the boiler shell. At the time the order was booked, the necessary 40-mm boiler plate was unobtainable in Switzerland so that the use of cast steel was envisaged for the boiler shell. Detailed investigations showed this to be entirely practicable, but more expensive. It became possible, however, to obtain the boiler plate from abroad, so that the cast-steel design was dropped. Only the two dished end plates are of cast steel, while the cylindrical shell is of boiler plate. These three parts are welded together electrically. An opening in the top plate admits the water-jet pipe, so that the strength of this plate cannot readily be computed from conventional formulas. The verification of the effective elongations and stresses under pressure, which was undertaken by the Swiss Association for the Supervision of Steam Boilers, was therefore of particular interest. The result showed that the stresses in the material nowhere exceed the permissible limits.

The full-load tests carried out on site were entirely satisfactory. The feedwater conditions, however, are far from favorable. It is well known that pure condensate is the ideal feedwater for an electric boiler on account of its high electrical resistance and its purity (the specific resistance of the condensate in industrial works can vary between 15,000 and several 100,000 ohm-cm at 20 C). For manufacturing reasons, no condensate is available in the present plant. All of the feedwater for the electric boiler is therefore thermally and chemically treated raw water. This feedwater has practically zero hardness but its specific resistance is only 2000 ohm-cm at 20 C. One of the advantages of the Brown Boveri water-jet boiler is, however, precisely that completely reliable service is obtainable with feedwater of so high conductivity. Even with still higher conductivities of the feedwater (300-400 ohm-cm at 20 C) there is no danger of flashovers. Since the boiler can operate with so high a concentration, the amount of water which has to be extracted for removal of salts is slight. This water is returned to the treating plant, where its heat content and part of the chemical constituents are utilized. In this plant trisodium phosphate is used for water purification which gives excellent results and prevents the formation of scale in the boiler. It may be recalled that Brown Boveri water-jet boilers have been operating satisfactorily for many years in other plants under similar difficult conditions.

Like all Brown Boveri electric boilers, this plant has the advantage of progressive regulation from zero to full load. The automatic regulating equipment permits service without attendance. The boiler has automatic pressure, load, feed, and salt-removal regulation. These regulating equipments operate with great precision so that stable and perfect regulation is now obtained. The sludge and salt-removal regulator has already been used successfully in connection with many electric boilers. It has various advantages over the earlier design in that it permits the concentration of the boiler water to be regulated as desired by simple adjustment of a reversing switch with several contacts. This possibility of adjustment enables the operation of the boiler to be adapted to the quality of the feedwater and the condition of the boiler.

The dimensions of the plant are small despite its large output. The entire supervisory and regulating equipment is mounted on a switchboard immediately adjacent to the boiler.

Fire-Resistant Panel

DEVELOPMENT of fire-resistant paneling that is said to protect human flesh within one inch of fire having a heat of 2200 F was announced recently.

Expected to reduce aviation fire hazards substantially and to have many other uses, the new panels are made of specially treated Du Pont "Strux" cellulose acetate plastic sandwiched between sheets of extremely thin (0.006 in.) carbon steel. Test panels are one-quarter inch thick and weigh less than a pound per square foot.

Civil Aeronautics Authority specifications for airplane firewalls require material to withstand applied heat of 2000 F for a period of 15 min. In official tests, the new steel and plastic paneling is reported to have withstood applied heat in excess of 2200 F for more than 30 min.

At the end of the test period the hand could still be held comfortably less than an inch from the panel on the side opposite from the fire.

Further unofficial tests have shown that the paneling stands up after more than an hour of exposure to a 2000-F flame.

An interesting sidelight on the construction of the panel is that the plastic core material, cellulose acetate, is not fire-resistant, being classified as slow-burning. In this application, however, as a result of special treatment by the Skydyne Corporation, Port Jervis, N. Y., developers of the paneling, the plastic, on exposure to heat, forms parchmentlike layers. These layers act as a heat barrier.

Although the new paneling is intended initially for the aircraft industry, many other uses are foreseen where lightweight and fire resistance are considerations.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Locomotive Developments

The Coal-Burning Gas-Turbine Locomotive, by John I. Yellott, Mem. ASME, Peter R. Broadley, and Charles F. Kottcamp, Mem. ASME, Bituminous Coal Research, Inc., Baltimore, Md. 1947 ASME Annual Meeting paper No. **47—A-118** (mimeographed).

The trends in the availability and cost of the two principal locomotive fuels, coal and Diesel oil, give added importance to the program of the Locomotive Development Committee of Bituminous Coal Research, Inc. Since May, 1945, the Committee has been developing a coal-burning gas turbine and a brief report on the current status of the program is presented.

COAL PREPARATION

The general principles of the coal-handling system are based on the assumption that the gas turbine must be able to burn any ordinary locomotive fuel without special wayside preparation. Drying, crushing, pressurizing, feeding, and atomizing must all be accomplished as the fuel is needed. Preliminary size reduction and drying are accomplished as the coal is being fed from the bunker by the stoker. Waste hot air from the turbine exhaust is available in virtually unlimited quantities for circulating through the jacket around the stoker screw trough. Direct mixing of the hot air with the coal can be used if necessary, but this expedient will be used only for exceedingly wet coal, to eliminate the necessity of cleaning the drying air before it is vented. A magnetic pulley has been added to remove tramp iron before the coal enters the hammer mill where it is reduced to minus eight mesh.

The feeding of coal to the turbine will be accomplished pneumatically by delivering the crushed fuel from the tank at a fixed rate to a stream of air at 150 to 200 psig.

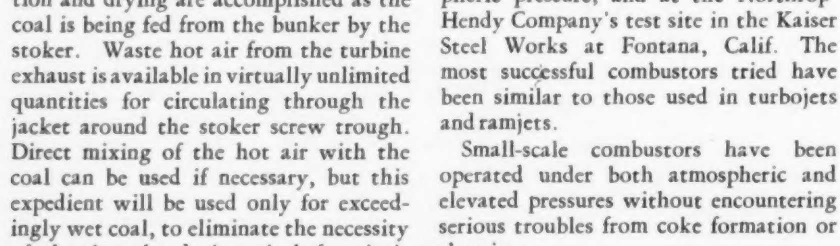
The coal-handling system is now being tested with full-scale equipment, following successful operation of small-scale apparatus at the Dunkirk, N. Y., pilot plant.

Since exceedingly fine pulverization appears to be necessary, the air-operated coal atomizer has been developed for supplying coal to the burners of the gas turbine. Tests made at Dunkirk in 1946 showed that the atomizer could produce superfine material (0.5 per cent + 100, 97.5 per cent —325) when enough air was used, at a top temperature of 400 F. Most of the work done since those tests was directed toward reducing the air-coal ratio to a more economical value, and eliminating the need for heating the atomizing air.

Full-scale work on combustion is now under way at Battelle Institute, at atmospheric pressure, and at the Northrop-Hendy Company's test site in the Kaiser Steel Works at Fontana, Calif. The most successful combustors tried have been similar to those used in turbojets and ramjets.

Small-scale combustors have been operated under both atmospheric and elevated pressures without encountering serious troubles from coke formation or slagging.

Tests at the Institute of Gas Technology showed that the removal of the larger components of the fly ash by the use of small mechanical separators rendered the combustion products virtually nonabrasive.



COAL-HANDLING SYSTEM

(1 Stoker drive, 2 elevator, 3 coal gate, 4 crusher, 5 conveyer, 6 coal pump, 7 coal tank, 8 transfer controller, 9 coal-feed motor, 10 pickup, 11 feed-control valve, 12 atomizer.)

GAS TURBINES

Gas turbines for the coal-burning power plant are now under construction by the Elliott Company and the Allis-Chalmers Company. The Elliott plant will use a two-stage centrifugal compressor delivering air at a maximum pressure of 55 psia through a regenerator to the combustion and fly-ash-removal system.

The Allis-Chalmers unit consists of a 21-stage axial compressor discharging through a regenerator at a maximum pressure of 75 psia to the combustion and fly-ash separation system.

The American Locomotive Company is designing a power unit to house the Allis-Chalmers plant, while the Baldwin Locomotive Works is concentrating on the Elliott unit. The Baldwin-Elliott locomotive is conservatively rated at 3750 turbine-shaft hp, with a maximum speed of 100 mph. The Alco-Allis unit has the same nominal rating, but the turbine power is likely to exceed 4000 hp. It is hoped that at least one unit can be on test during 1948.

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Coupon books and copies of papers are obtainable from ASME Publication Sales Department, 29 West 39th Street, New York 18, N. Y.

Pennsylvania Railroad 2000-Hp Streamlined Diesel Road Locomotive, by J. C. MacInnes, The Baldwin Locomotive Works, Philadelphia, Pa. 1947 ASME Annual Meeting paper No. **47—A-73** (mimeographed).

The latest of Baldwin Locomotive Works' Diesel-electric developments is a new 2000-hp unit for the Pennsylvania Railroad, designed for main-line freight and passenger service. These 2000-hp units manufactured in "A" and "B" units or "lead and booster" units may be coupled in various combinations to meet any horsepower demand, which is a distinct advantage of the multiple-unit locomotive.

This 2000-hp Diesel-electric locomotive unit is powered by two 6-cylinder 1000-hp supercharged engines. Each locomotive unit rests upon two 6-wheel trucks, with traction motors geared to two axles of each truck. The weight of each unit is approximately 180 tons with 60,000 lb on each axle. The over-all length of each unit (inside knuckles) is approximately 80 ft and the total length of a 6000-hp locomotive made up of two A units and one B unit is 238 ft 3 in.

With a 22:57 gear ratio, each unit is capable of supplying a continuous tractive effort of 26,400 lb at 23.8 mph and a starting tractive effort of 60,000 lb at 25 per cent adhesion. The unit is reported to be capable of attaining a maximum safe speed of 100 mph on straight level track.

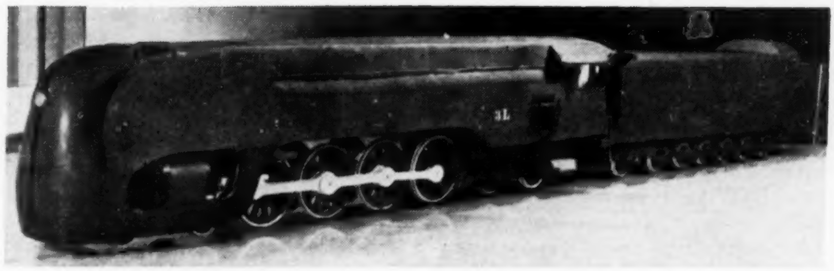
The Diesel engines powering the 2000-hp units are the Baldwin-type 606-supercharged engines. This is a vertical 4-cycle engine with a $12^3/_4$-in. bore and a $15^1/_2$-in. stroke, developing rated horsepower at 625 rpm. The supercharging is accomplished by the Buchi system.

The cab is functional as well as affording the utmost in eye appeal. Among its many advantages is a trap door in the top of the nose, just forward of the cab windows, to permit cleaning while en route. Another feature is that the entire top of the nose can be unbolted and removed and in this space may be found the air-brake equipment, suitably mounted on a common rack for quick and simplified replacement if the necessity arises.

The running gear, engine lubrication and cooling generators, auxiliary equipment, etc., are described.

Streamlining Effect on Air Resistance and Smoke Lifting on Steam Locomotives, by J. F. Griffin, Mem. ASME, The Superheater Company, East Chicago, Ind. 1947 ASME Annual Meeting paper No. **47—A-82** (mimeographed).

All motive power has to overcome wind resistance. This resistance can be held to a minimum by suitable streamlining but on the steam locomotive the streamlining is limited to that which will not interfere with maintenance and servicing. A steam locomotive also presents the problem of preventing smoke from curling around the cab and obstructing the vision of the engineer and fireman. This is referred to as smoke trailing and is caused by too low a velocity at the outlet of the stack for the conditions under which the locomotive is operating.



LOCOMOTIVE WITH HUET STREAMLINING AND SMOKE LIFTERS

A test was conducted in 1946 in the wind tunnel at the Daniel Guggenheim School of Aeronautics at New York University with a $^1/_{12}$-scale model of an existing modern 4-8-4 type locomotive. To this model was added for various runs, different features of streamlining or smoke-lifting deflecting plates or both. Each change constituted, in effect, a different model. This paper covers a report on the five models which proved to be most important. The design by André Huet is described in detail in the text, but briefly, it is a novel design arranged to convert air velocity into pressure so as to build up a layer of air at least to atmospheric pressure around the locomotive to reduce skin friction, and to prevent low-pressure points being formed, which would draw the smoke and exhaust steam down around the locomotive.

The results obtained on these tests were such that if they can be duplicated in road service, make it appear possible not only to reduce smoke trailing but also to decrease stack velocities; and at high speeds to effect a reduction in wind resistance. The latter would add directly to the drawbar horsepower. A decrease in stack velocities would mean a decrease in exhaust pressure which could be utilized to increase the drawbar horsepower.

"Full streamlining" (considered impractical from a maintenance and servicing standpoint), gave less wind resistance than any model tested. However, it was not entirely satisfactory from a smoke-lifting standpoint. When smoke-lifting deflecting plates were applied they helped the smoke lifting, but did not entirely prevent smoke trailing.

The Huet design of streamlining was almost as good as the full streamlining from a wind-resistance standpoint. Its performance from a smoke-lifting standpoint was remarkable, exceeding all other models tested by a wide margin. Even with high locomotive speeds and 1-lb exhaust pressure there was no smoke trailing, indicating stack velocities might be decreased considerably without smoke trailing.

A locomotive with a special streamlined nose and with smoke-lifting deflecting plates showed a small reduction in wind resistance. In this regard it ranked third with the five models tested. From a smoke-lifting standpoint its performance was about equal to that of the bare locomotive with smoke-lifting deflecting plates. With it there was no indication that stack velocities could be reduced.

The orthodox smoke-lifting deflecting plates applied to a bare locomotive increased the wind resistance slightly. They were quite effective from a smoke-lifting standpoint. However, their performance in this respect was not as good as the Huet design of streamlining with smoke lifters.

The bare locomotive gave considerably higher wind resistance than any streamlined models tested and showed up poorly as compared with the other models from a smoke-lifting standpoint.

The types of tests made; description of models used; test equipment and methods employed; test data, calculations, and corrections; and conclusions, are included. In addition, 25 photographs, diagrams, and graphs illustrate the paper.

The Effect of Foundation-Brake Equipment on Emergency-Stop Distances, by C. D. Stewart, Mem. ASME, Westinghouse Air Brake Company, Wilmerding, Pa. 1947 ASME Annual Meeting paper No. **47—A-129** (mimeographed).

One of the requisites for safety in the railroad industry is the ability to control the speed and to stop within practical dis-

tances. To this end the basic braking forces on modern passenger-train cars have been increased with the advent of modern streamline trains, from 150 per cent maximum to 250 per cent. The 250 per cent braking ratio has been provided on the majority of new passenger equipment cars built in recent years. Repeated attempts have been made to do the same for modern locomotives but numerous difficulties have been encountered. As a result of all recent efforts, the maximum over-all braking force that is now found on any modern locomotive does not exceed 200 per cent. Modern cars are braked to the practical limit of 250 per cent on all axles. This braking ratio occurs at train speeds above 65 mph. To modify this force for lower speed, speed-governor control is employed to vary the braking force downward with reduction in speed. These high braking ratios in turn impose higher brake-shoe loads and to keep the unit shoe forces within practical limits clasp brakes and larger shoes are employed to increase the braking surface.

In considering the possibility of increasing the locomotive braking ratio, various axles present individual problems and each must therefore be given careful consideration. Also, in the case of steam locomotives, the loaded tender braking ratio has been low because of the need to compromise between empty and loaded weights. This problem is now much nearer solution through the use of a variable load tender brake. This brake provides a materially higher braking ratio for loaded conditions but holds the maximum braking ratio for a lightweight condition to that which will avoid wheel sliding, particularly at low speeds.

The steam engine, the Diesel-electric, and the electric locomotive, also present a difficult problem. Furthermore, because of their greater weight and hence their effect on the train-stop distance, it is very important that the highest practical braking ratio be employed. Several values of braking ratios up to 250 per cent are discussed. A tabulation of foundation-brake data for a representative number of each of the several types of locomotives is also given.

Water Purification

Low-Pressure Steam-Heated Distilling Plants, by A. M. Impagliazzo, Jun.ASME, and R. M. Bent, The Griscom-Russell Co., New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-86** (mimeographed).

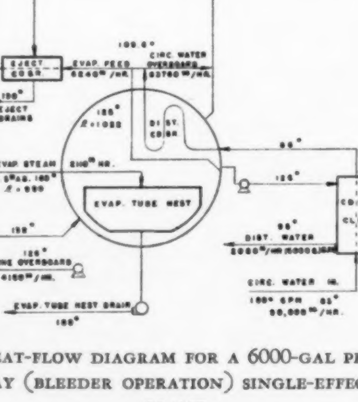
The relatively high steam pressures currently in use in marine power plants superimposes on the old problem of supplying general-purpose fresh water the need of extremely pure water for boiler feed. Use of the low-pressure steam-heated distillation plant for supplying water for both purposes offers many advantages from an economic and engineering standpoint. These advantages are discussed with reference to the "package-type" distilling plant recently made available in normal-rating capacities from 9230 to 60,000 gal per day.

Recent studies show that installation costs can be justified on some vessels because the plants make available additional cubic capacity and reduce dead weight by eliminating fresh-water storage tanks. Substantial profits can be realized on distilling plants in investment on larger ships but on smaller cargo vessels economic justification can be dubious.

On the Venore class, service experience showed that while at sea, a well-designed plant could produce regularly a distillate having a sea-salt content of 0.1 grain per gal. Potable water could be produced regardless of the temperature of evaporation providing no priming occurred. Plants equipped with an automatic device to discharge distillate overboard when sea-salt content exceeds 0.25 grain per gal have been approved by the United States Public Health Service.

Scale formation is not a serious problem because of the low-heat steam and low boiling temperature. "Cold shocking" once daily is customary. Use of a Navy compound-cornstarch feed treatment is claimed practically to eliminate scale.

Engineering considerations of a typical low-pressure steam-heated plant are discussed and control devices which simplify operation and provide a considerable measure of automatic control are listed. Fuel-economy data for single- and double-effect plants are given, also a heat-flow



HEAT-FLOW DIAGRAM FOR A 6000-GAL PER DAY (BLEEDER OPERATION) SINGLE-EFFECT PLANT

diagram for a 6000-gal per day (bleeder operation) single-effect plant.

The distilling plant is a vital piece of equipment on the modern ship. It should be constructed to outlast the life of the ship. Nonferrous materials such as cast bronze and 70-30 copper-nickel alloy are generally specified.

Oil Elimination From Feedwater, by M. Bradt, Mem. ASME, Skinner Engine Company, Erie, Pa. 1947 ASME Annual Meeting paper No. **47—A-90** (mimeographed).

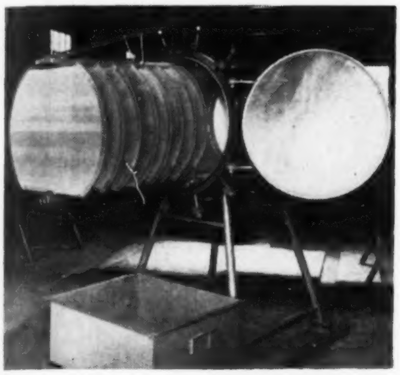
With the introduction of the uniflow engine into the marine field and the use of higher steam pressures and superheat, the removal of oil from boiler feedwater is an urgent necessity if boiler tubes are not to be damaged by overheating. To meet this problem three types of filters have been developed. One uses chemical neutralization and absorption, another uses diatomaceous-earth neutralization and absorption, and the third uses diatomaceous-earth neutralization and stripping.

Development of the tyndallometer which uses a beam of light to detect oil in condensate has helped to answer the important question of how much oil was present. The type of filter equipment best for a particular installation depends on the physical form of oil in condensate, method of boiler-water treatment, and the type of service. Presence of emulsified oil complicates the removal problem because free oil calls for a different treatment. The type of feedwater treatment is important because with some types more oil can be present without damage to boilers than with others. The problem is also easier with vessels operating in fresh-water service where an unlimited supply of backwash or waste water is available.

Since free oil rises to the surface of water at rest, the removal of free oil is relatively simple. The old type of feed-and-filter boxes could remove 97 per cent of such oil, but none of that in the emulsified state which requires neutralization followed by absorption or stripping for satisfactory removal.

In the neutralization-absorption method, chemicals or diatomaceous earth are added to the condensate to form a "floc" which neutralizes the emulsified oil and also forms a mat on top of a sand bed or, in the case of the diatomaceous earth filters, on a series of screens.

In the neutralization-stripping method, diatomaceous earth with a tightening agent is fed to the condensate. The earth neutralizes the emulsified oil while the earth and tightener form a tight cake



LEAF-TYPE CONTINUOUS SLURRY FEED FILTER USING DIATOMACEOUS EARTH

on a screen which strips neutralized oil. This rises to the surface and is removed. The small amount which passes through the filter cake is removed by a terry-cloth filter.

Efficient filtration equipment should be installed as auxiliary to every type of steam prime mover if boilers are to be protected from oil. Choice of equipment will depend on weight, floor space, class of operator, and service of vessel. The three general types of filtration equipment now available are all capable of meeting U. S. Navy and U. S. Maritime Commission specifications.

Demineralization Processes, by D. J. Saunders, The Permutit Company, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-138** (mimeographed).

This paper describes a two-step demineralizing process capable of producing water having an electrolyte content equivalent of commercially distilled water. In the first step, raw water is passed through an acid-regenerated zeolite. In this operation the sodium, calcium, and magnesium ions are removed by the zeolite and exchanged for the hydrogen ion. The effluent therefore contains hydrochloric, sulphuric, and carbonic acids in amounts equivalent to the chloride, sulphate, and bicarbonate content of the raw water. Demineralization is completed in the second step during which these acids are removed. An acid-absorbent anion exchanger removes the hydrochloric and sulphuric acids. The carbonic acid is removed by degasification.

When low dissolved silica is desired in the demineralized water, special methods of treatment must be employed. Two basic methods of removing silica are discussed.

Cost of demineralizing regenerants are given in tabular and curve data. One table shows that reagent costs of a water having 125 ppm of dissolved solids was 2 cents per 1000 gal and a water of 1250 ppm of dissolved solids was 79 cents per 1000 gal.

The investment and labor costs for demineralization are generally much lower than for evaporation.

Technical and Economic Aspects of Water Purification for Ships, by R. V. Kleinschmidt, Mem. ASME, Arthur D. Little, Inc., Cambridge, Mass. 1947 ASME Annual Meeting paper No. **47—A-136** (mimeographed).

The Kleinschmidt vapor-compression distilling unit was developed for the Marine Corps as a simple and economical means of producing potable water for landing operations. The unit has five major parts, a source of mechanical power, a steam compressor, an evaporator, a heat exchanger, and a source of heat for starting the unit.

This paper compares the Kleinschmidt method of distilling water with the conventional steam-heated evaporator in respect to fuel efficiency, purity of distillate, capacity, simplicity of control, ease of cleaning, and finally over-all cost. Cost of water produced by the unit is of the order of from one to five cents per day per person aboard.

Six specific applications of the unit are discussed.

Heat Transfer

Heat Transfer Through Thick Insulation on Cylindrical Enclosures, by T. S. Nickerson, E. I. du Pont de Nemours and Co., Belle, W. Va., and G. M. Dusinberre, Mem. ASME, University of Delaware, Newark, Del. 1947 ASME Annual Meeting paper No. **47—A-63** (mimeographed).

This paper treats the problem of finding the heat flow through relatively thick insulation applied to an enclosure having the form of a short cylinder such as a tank. In this case incorrect treatment of the corner effect may lead to serious error. A graph is presented based on the "relaxation" method of calculation which gives area ratio f, effective area of heat transfer to inner area of insulation in terms of the diameter to length ratio D/L, and the insulation thickness to diameter ratio x/D. With the value of the area ratio, heat transfer can be calculated by the usual equation for a flat slab.

Use of the chart gives numerical solutions which agree with the analytical solution within 3 per cent. In addition to an example showing application of the chart, an appendix is included outlining method of determining curves.

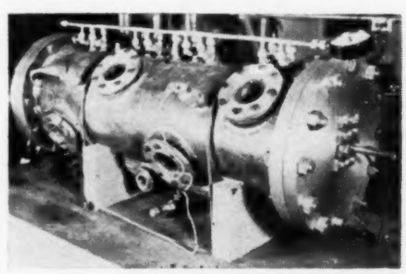
Condensation of Refrigerant Vapors—Apparatus and Film Coefficients for Freon-12, by R. E. White, York Corporation, York, Pa. 1947 ASME Annual Meeting paper No **47—A-91** (mimeographed).

Heat-transfer film coefficients for condensing vapors have usually been determined indirectly from over-all coefficients using the Wilson reciprocal plot. When direct determinations have been attempted, the results have been inaccurate.

This paper describes the details of construction of an apparatus designed primarily to give accurate heat-transfer data under closely controlled ideal conditions (the basis of the Nusselt derivation). The paper also gives data on the condensation of saturated Freon-12 under ideal conditions on a plain horizontal tube at various vapor temperatures and film-temperature drops.

The apparatus consists of a boiler and condenser enclosed in a constant-temperature chamber. Heat is supplied by electric rod, and condensing surface is provided by a $^5/_8$-in-OD highly polished nickel tube 36 in. in length. Tube-wall temperature is determined by the electrical-resistance method described by J. P. Jeffrey, Cornell University, Engineering Experiment Station, Bulletin 21, 1936.

The heat-input reading q was converted to Btu per hr and this value when divided by the condensing-surface area gave the heat flux q/A. From the heat flux and the conductivity of the tube material, the temperature gradient across the tube wall was calculated. The average tube-wall temperature plus one half the gradient gave the tube-surface temperature. The film coefficient h was obtained by dividing the heat flux by the difference in temperature between tube surface and the average vapor temperature.



FRONT VIEW OF APPARATUS WITHOUT INSULATION USED FOR OBTAINING FILM-COEFFICIENT DATA FOR FREON-12

Experimental data obtained under conditions as nearly ideal as possible were 13 per cent below the values predicted by the Nusselt equation for condensation of Freon-12 at elevated pressures.

Condensation on Six Finned Tubes in a Vertical Row, by D. L. Katz, Mem. ASME, and J. M. Geist, University of Michigan, Ann Arbor, Mich. 1947 ASME Annual Meeting paper No. **47—A-96** (mimeographed).

Condensing heat-transfer coefficients for Freon-12, n-butane, acetone, and water were obtained for six horizontal finned tubes in a vertical row. The over-all heat-transfer coefficients were measured for each tube at a series of water velocities and were plotted by the method of Wilson to obtain the condensing coefficients. The differences between experimental and predicted coefficients for the top tube were less than 14 per cent, and the average condensing coefficient for the six tubes was less than 10 per cent below that for the top tube. The finned surface was entirely effective for condensation even for organic liquids having a tendency to be retained by the fins under static conditions.

It is concluded that for design purposes Nusselt's theory, applied to a bank of horizontal finned tubes, will give condensing heat-transfer coefficients safe and well below the expected experimental values.

The paper describes equipment used in obtaining data, visual observations made of condensate dripping from tubes during the tests, and outlines calculations. Extensive data obtained for the various condensing vapors are also included.

Heat Transfer and Fluid Friction During Viscous Flow Across Banks of Tubes, by G. A. Omohundro, O. P. Bergelin, A. P. Colburn, Mem ASME, University of Delaware, Newark, Del. 1947 ASME Annual Meeting paper No. **47—A-102** (mimeographed).

This paper is the first contribution from the Heat Exchanger Research Project sponsored by the ASME and conducted by the University of Delaware in co-operation with manufacturers and users of heat exchangers.

The project is planned as a two-front attack on the correlation of fluid-friction and heat-transfer data obtained from studies with idealized models and commercial tubular heat exchangers over a wide range of variables and under standardized conditions of equipment and technique.

The paper reports a study on a model unbaffled heat exchanger consisting of a rectangular steel shell containing seventy $^3/_8$-in-OD copper tubes rolled into two forged-steel tube sheets. A rather viscous oil was chosen for this study so that data could be obtained in the region of viscous flow in which few data are currently available.

Heat-transfer coefficients during cooling, and pressure-drop data during both isothermal and cooling runs are reported for low velocities, chiefly in the region of viscous flow.

On the basis of uniformity of friction and heat-transfer data obtained and the agreement of these data with average values of previous investigators, it is concluded that the equipment and technique devised are satisfactory for the purposes of the co-operative project.

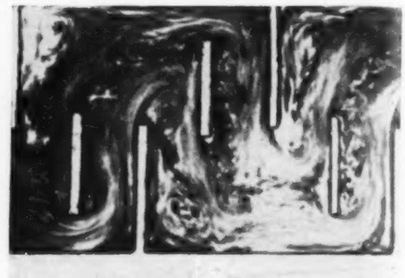
Correlation of isothermal friction data by a method proposed by previous investigators suggests that tube size or pitch have an effect not exactly covered by old correlation methods. The data also suggests that a viscosity correction which is a function of the flow rate is needed for the correlation of cooling data with isothermal friction data. In general, the heat-transfer data seem to fall near the curve previously drawn parallel to data obtained using single cylinders.

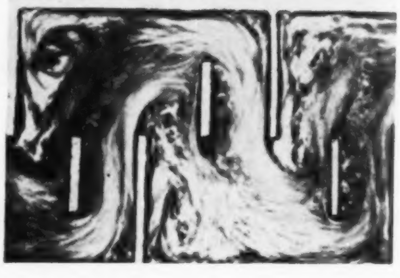
Extensive curves and tabulated data are included with the paper.

A Study of Flow Patterns in Baffled Heat Exchangers, by A. Y. Gunter, Mem. ASME, American Locomotive Company, Houston, Texas, H. R. Sennstrom, Mem. ASME, American Locomotive Company, Schenectady, N. Y., and S. Kopp, Mem. ASME, American Locomotive Company, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-103** (mimeographed).

This study is a contribution to the literature on heat transfer and fluid flow. While many studies are available of flow patterns around single tubes, tube banks, and through tubes and fittings, this paper is reported to be the first covering flow-pattern studies in baffled heat exchangers of the shell-and-tube type commonly used by industry.

Tests were designed (1) to give flow patterns for an ideal baffled shell-and-tube heat exchanger covering a wide range of baffle arrangements; (2) to indicate possible improvements in flow pattern with attendant heat transfer for heat exchangers using cross-flow baffles by introducing intermediate baffling; and (3) to encourage further research in this field.





TWO OF THE MANY PHOTOGRAPHS OBTAINED IN A STUDY OF FLOW PATTERNS IN BAFFLED HEAT EXCHANGERS

Only qualitative results were obtained. These call for additional work before they can serve as a working tool for designers, engineers, or users of heat exchangers.

Work was done using two-dimensional models $1^1/_2$ to $2^1/_2$ in. in width, $^1/_4$ to $^1/_2$ in. in depth, and long enough to include several baffles. The flow fluid was a solution of distilled water and powdered aluminum to which a wetting agent was added. Flow patterns were photographed using reflected light and shutter speeds slow enough to obtain traces of individual aluminum particles.

By means of this technique a well-defined flow pattern was obtained for the various baffle arrangements tried. It was found that baffle-spacing and baffle-overlap influence the flow pattern and change the flow area taken by the main stream. When intermediate baffles were added between the main-stream baffles, the flow area of the main stream increased and the area taken up by eddies and whirlpools decreased. Flow patterns reveal that there is some flow throughout a cross-baffled heat exchanger, and that even in the so-called "dead spots" some heat transfer occurs.

Observations indicate possible improvements in shell-side baffling of shell-and-tube heat exchangers. Additional studies are desirable, preferably with the three-dimensional models.

Photographs of 75 flow patterns are given as well as pertinent data about the models and baffle arrangements used in the studies.

Freight-Car Construction

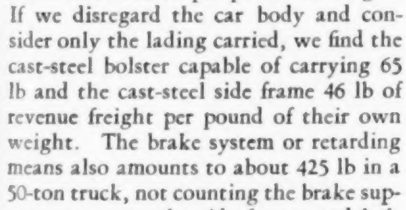
Freight-Car Truck Progress, by R. B. Cottrell, Mem. ASME, American Steel Foundries, Chicago, Ill. 1947 ASME Annual Meeting paper No. **47—A-71** (mimeographed).

The great strides made since 1914 in the design of cast-steel side frames and bolsters for freight-car trucks are discussed. Not only has the strength of the castings been greatly increased, but it has been accomplished without a corresponding increase in weight.

The truck of the present-day 50-ton freight car has a weight complete of about 14,000 lb in grade "B" steel, and is capable of transporting 110,000 lb of material safely and without damage at speeds up to 100 mph. The trucks also support the car body, which in some cases weighs 40,000 to 45,000 lb, making 150,000 to 155,000 lb in all. This is 11 lb of load carried per pound of truck weight.

The cast-steel truck bolster in a modern 50-ton freight-car truck actually supports about 90 lb per pound of its own weight, and the cast-steel side frame about 65 lb per pound of weight. If we disregard the car body and consider only the lading carried, we find the cast-steel bolster capable of carrying 65 lb and the cast-steel side frame 46 lb of revenue freight per pound of their own weight. The brake system or retarding means also amounts to about 425 lb in a 50-ton truck, not counting the brake support means on the side frames and bolsters. Further analysis shows that the forged-steel axles carry 34 lb of revenue freight per pound of weight and the one-wear steel wheels $24^1/_2$ lb, indicating the excellent efficiency and weight economy of the cast-steel side frame and bolster.

Static tests and strain-gage analyses made from 1914 to 1918 clearly indicated the superiority of the U section, and designs began to appear in which the tension member, as well as the compression member, was made this way, although cost of manufacture was increased due to additional coring, etc. The best-known example of these early U-section frames was the "Administration," or USRA designs. They were completely U sections with the exception of the bottom member below the spring seat. This was the foundation upon which present-day designs rest. The casting of the journal boxes integral with the frame and the use of re-entrant flanges, cross ties, beads, and pocket-type spring seat has resulted in an exceptionally strong yet lightweight structure.

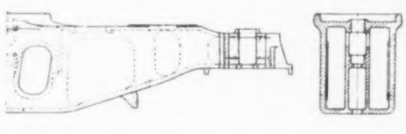


SIDE FRAME FOR MODERN HIGH-SPEED FREIGHT-CAR TRUCK

Progress in cast-steel truck-bolster design has kept pace with that of side frames. Early-type bolsters were of what was known as the inverted U and "bulb" section designs.

The bulb section was superseded by the so-called "T" section for strength as well as foundry reasons.

The "full-box section" cast-steel bolster came out about the same time the "full-U section" side frame made its appearance. A considerable improvement was made in strength, but cost of manufacture went up due to the internal coring that was necessary.



BOX-SECTION BOLSTER FOR MODERN FREIGHT-CAR TRUCK

The box-section bolster construction like the U-section side frame, has demonstrated by test and service its superiority from a strength and weight standpoint. Refinements have been made such as straightening bottom and top members, judicious use of internal ribbing, holes through side walls for brake rods, and the like.

Evidence of the steady progress is illustrated by facts and figures in 14 tables.

Development and Trend in the Design of Hopper-Discharge Types of Railway Cars, by G. A. Suckfield, Pressed Steel Car Company, Inc., Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-78** (mimeographed).

The development and trend in the design of hopper cars for general railroad interchange service, since 1897, are reviewed.

The first period extended from 1897 to about 1918; the second, from 1918 to 1935; and the third, from 1935 to the present time.

In the first period the steel car and the steel hopper car were new and a wide variety of construction details were developed and built into cars. A feature that still remains among the most favored is the saw-tooth arrangement of hoppers, and another, the 30-deg slope for end floor. By the end of this period most railroads were specifying continuous center sills formed of rolled sections, bulb angles for reinforcing top of sides, 5-in. × 7-in. shank couplers, friction draft gear, and arch-bar trucks.

Prior to 1928, most general-purpose hopper cars utilized flat side sheets with reinforcing members on the outside of the car, but about 1928 many roads changed their sides by sloping the side sheets in near the top, placing stiffening stakes on the inside.

In the second period, 6-in. × 8-in. shank couplers with cast-steel yokes and key attachments and cast-steel side-frame trucks came into general use. Also, hooks and latches for locking hopper doors advanced in favor over other devices.

Creation of this design and the wide distribution of the detail drawings for it paved the way for the adoption of the AAR standard hopper car which was designed in 1934 and which represented the third period. One of the new design features is the welded Z section center sill and another, the one-piece hopper chute with welded door frame. It also took advantage of changes in road clearances and loading rules to provide sufficient capacity to receive a load of coal equal to the rail-load-limit weight minus empty-car weight. By the time this car was developed, couplers and attachments, dimensions for draft gear, and essential dimensions for trucks had been standardized, and "AB" brake equipment was required on all new cars.

The Pressed Steel Car Company, in 1934, designed a car to take full advantage of the physical properties of the then new Corten steel and those of high-tensile steel castings to provide a car of minimum weight which would carry the maximum allowable load of coal and other bulk materials.

Twelve years' experience with these ultralightweight cars on three railroads shows that they are providing service life comparable with that of $^1/_4$-in. copper-bearing steel floors in hopper cars and suggests that slightly heavier Corten steel sheets equally well supported will outlast $^1/_4$-in. copper-bearing steel.

As of July, 1947, a newly designed car, combining Corten steel and arc welding, had been developed and built by the Railway Research Bureau of the Carnegie-Illinois Steel Corporation Subsidiaries

A car was developed by the Aluminum

Company of America in 1947 to utilize aluminum for body structure, except for center sills and bolsters which are of carbon steel.

This review also shows that tomorrow's favored hopper car, if not today's, will be a steel car of welded design with improved riding trucks and more efficient brakes; that weight should be the minimum that will assure reasonable service life, particularly in parts subject to combined action of abrasion and corrosion, and that the substitution of low-alloy high-tensile steel for carbon steel in hopper cars will permit reducing weight, increase capacity, and lengthen service life of parts for an added cost that is justified.

Facts and figures of nine designs of hopper cars built in 1897 to the present are given in two tables.

Weight Reduction—Freight Cars, by R. B. Borucki and E. A. Sipp, Reynolds Railway Division, Chicago, Ill. 1947 ASME Annual Meeting paper No. **47—A-79** (mimeographed).

Weight reduction can be made by either sound engineering analysis of present ferrous materials or adoption of lightweight nonferrous materials such as aluminum alloys or magnesium alloys.

It is shown that the use of aluminum in a box car designed by Reynolds Metals Company resulted in a weight reduction of 7880 lb or approximately four tons over the standard car.

Hopper cars are also discussed and weight comparisons are made.

For the use of aluminum alloys in the design of freight cars the following recommendations are made:

The alloys best suited for load-carrying framing are, in the order of preference, 17S-T, R 361-T, and R 361-W. Alloys 17S-T and R 361-T should be used wherever no severe offsetting or forming is required.

R 361-W is recommended for parts requiring severe offsetting or forming. The strength of R 361-W is about one half the strength of R 361-T or 17S-T, and if aluminum parts are designed to equal deflection of similar steel parts, usually the stresses will be low enough to use R 361-W. When maximum strength is required, then the formed shapes can be age-hardened to R 361-T. Shapes of 17S-T or R 361-T can be offset or formed by heating the material to 450 F if not allowed to remain at this temperature for more than half an hour; otherwise, the longer period will affect the temper and cause loss of tensile strength.

For outside sheathing of car, aluminum alloys recommended are, in the order of preference, R 301-T, R 301-W, R 301-O, R 361-W, and R 361-O. Alloys in "T" temper should be used for parts without severe bends or flanges and only when the proper-bend radii can be used. For parts requiring flanging and some forming, and if proper bend radii can be used, "W" temper alloys should be used. For parts requiring severe forming combined with a draw, "O" temper, which is in the annealed state, should be used. Alloys in the O temper can be heat-treated to W or T if strength is required. Whenever heat-treating of formed parts is required, the services of an aluminum metallurgist or service engineer should be engaged. In the heat-treating operation, considerable distortion will be experienced, varying in intensity according to the size and shape.

Aluminum alloys for rivets are recommended, in their order of preference, as follows: A 17S-T, 53S-T61 or 53S-W or R 361-W. Usually rivets up to $^1/_2$ in. in diameter can be driven cold with a hand, pneumatic, or power-squeeze riveter. Rivets larger than $^1/_2$ in. in diameter should be driven hot. All riveting of course should be done with power-squeeze machines. A modified cone head on the driven side is recommended in preference to the button head because it takes less pressure to form such a head and the strength is equal if not greater. Aluminum parts exposed to alkaline materials should be coated with zinc or zinc-chromate paint.

Weatherproofing of riveted joints should be with a mastic material which will not harden and will not be injurious to aluminum.

Freight-Car Construction, by G. B. Hauser, Mem. ASME, Aluminum Company of America, Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-89** (mimeographed).

The application of aluminum alloys in the design of freight cars is discussed.

For most freight-car uses, Alcoa has standardized on alloy 61S. It is an aluminum-magnesium silicide alloy characterized by moderately high strength and good formability. The magnesium-silicide alloys are more corrosion resistant than the higher-strength copper-bearing alloys. In the annealed state it has a typical yield strength of 8000 psi, ultimate strength of 18,000 psi. In the solution-heat-treated temper, it has a yield strength of 21,000 psi, and ultimate strength of 35,000 psi. In the fully aged condition it has a yield strength of 40,000 psi and ultimate strength of 45,000 psi.

For rivets, 53S-T61 alloy is generally recommended. It has a shear strength of 23,000 psi. This temper is for cold driving only and can be used up to $^1/_2$ in. in diameter when hand-driven, or in almost any diameter when power-driven. The same alloy rivet in the solution-heat-treated temper is recommended for hot-driving work which is usually employed when hand-driving rivets over $^1/_2$ in. in diameter. Depending upon the heating temperatures used, shear strengths between 18,000 psi and 24,000 psi may be obtained.

In one or more of its tempers 61S alloy has been adapted to the manufacture of parts for hopper cars over steel designs. A hopper car designed specifically for aluminum alloys would permit practically all parts to be pressed cold in either the solution-heat-treated or artificially aged temper (61S-T4 or T6).

Aluminum-alloy tank-car tanks are built either of riveted or welded construction and meet all required tank-car specifications. The welded tank is designed around the strength of the welded joint and meets AAR Specification 201-A-35W. For this specification, Alcoa alloys 2S, 3S, and 61S are generally employed; the commodity to be carried governs the choice of alloy. All welded tanks are today being welded by the Argon shielded-tungsten-arc process. Under the experimental ICC Classification 103-AL, Alcoa alloy Alclad 14S-W is used in a riveted tank.

Essentially, refrigerator and boxcar designs are similar and past experience indicates that all parts can be successfully fabricated in aluminum alloys. From a strength standpoint, additional side stiffeners are required to resist the bulging load when the car is considered to be loaded with wheat.

The reasons for lightweight construction in freight cars, namely hopper cars, tank cars, refrigerator cars, and boxcars are also given. Weight comparison between aluminum and steel construction shows what weight can be saved. A brief discussion of the economics of lightweight construction is included.

Weight Reduction—Freight Cars: AAR Standard Air Brake—AB Single-Capacity Freight-Brake Equipment, by H. N. Sudduth, Jun. ASME, The New York Air Brake Company, Watertown, N. Y. 1947 ASME Annual Meeting paper No. **47—A-106** (mimeographed).

The single-capacity freight brake, known as the AB freight brake equipment, is required on new interchange cars to meet the specifications of the Association of American Railroads and the Interstate Commerce Commission. It includes the AB valve which is the con-

trolling element comprising a pipe bracket and two valve mechanisms mounted thereto, a retaining valve, a combined dirt collector and cutout cock, a branch pipe tee, an auxiliary and emergency reservoir combined in one unit, a brake cylinder, two angle cocks, and two standard air-brake hoses with couplings. The total weight per car set is approximately 664 lb, of which the combined reservoir accounts for approximately 262 lb, the AB valve approximately 171 lb, and the brake cylinder approximately 160 lb. Currently and in the past, with few isolated exceptions, these three items have been made almost wholly from cast iron, bronzes, zinc die castings, steel, and rubber. By far the largest weight is represented by the cast-iron content of the reservoir shells, the valve bodies, the pipe bracket, the brake-cylinder body, brake-cylinder nonpressure head, and the brake-cylinder piston.

It is pointed out that the best opportunity for weight reduction is offered in the combined auxiliary and emergency reservoir. Studies of several designs and samples of fabricated steel have led to the conclusion that a practical solution would reside in the furnishing of this item in a form which would be universally applicable to the single-capacity AB brake and the later modification known as the AB load-compensating brake. A design which appears to be thoroughly acceptable in Corten steel would result in a weight saving over the present cast-iron design of approximately 145 lb, and it could be made available when and if specific requests for such lightweight construction are received on a national basis.

Economics of Application of High-Strength Steel in Freight Cars, by A. F. Stuebing, Mem. ASME, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-107** (mimeographed).

Substantial cost savings are possible through the use of high-strength steels in the construction of hopper cars if they are designed also for weight reduction and increased loading capacity. If, however, no weight saving is sought, the net economy will be reduced substantially, except in service where copper-steel body sheets have an abnormally short life. Similarly, savings may be assured in building gondola cars and boxcars if they are designed properly for the use of the same class of low-alloy high-strength steels.

The determination of the most economical construction for freight cars involves a proper balance between the factors of first cost, depreciation, maintenance, and operating expenses, to produce the minimum over-all cost. It is evident that if designers were permitted to disregard weight or to use any available material irrespective of first cost, they could produce a car of such construction that its maintenance would be exceptionally low. However, it is unlikely that such a car would be economical because the higher fixed charges and operating cost would probably more than offset the savings effected in repairs.

It would be equally shortsighted to overemphasize low first cost at the expense of greatly increased maintenance and depreciation expense. Similarly, if special attention is directed to any other single item of expense, that one item may be reduced, but others are likely to be increased. In any discussion of the savings that can be effected by reducing the weight of freight cars, due consideration should therefore be given to the effect which the proposed change will have on all items of railroad expense.

As a means of illustrating the comparative expenses that may be expected to result from various types of freight-car construction, estimates have been made for cars with bodies of conventional construction using copper steel and alternative designs using high-strength steel. The types analyzed are hopper cars, gondolas, and boxcars.

To determine the relative costs that should result from the application of high-strength corrosion-resisting steel in hopper cars, calculations have been made for four different proposed designs, all on $5^1/_2$-in. × 10-in. trucks.

Because gondola cars can usually be loaded to their maximum carrying capacity, reduction in weight of the empty car results in operating savings comparable to those effected by weight reduction in hopper cars.

Representative high-strength-steel designs with varying degrees of weight reduction in the body structure have now been in service ten years or more and results indicate that this construction provides ample strength, stability, and serviceability.

In calculating the savings effected by reduction in weight of boxcars, the assumption is generally made that lightweight boxcars will carry no more load than conventional cars. This disregards the effect of increased capacity in the loading of wheat and other grains, and some other commodities, which can utilize the full-load limit of the car.

Tables showing relative costs for the various freight cars accompany the paper.

Roller-Bearing Applications for Modern Freight Cars, by M. S. Downes, The Timken Roller Bearing Company, Canton, Ohio. 1947 ASME Annual Meeting paper No. **47—A-135** (mimeographed).

Roller bearings have been considered as standard equipment on passenger cars and all types of main-line railroad locomotives for more than ten years. It is just recently, however, that serious consideration has been given to the application of roller bearings on main-line freight cars.

Freight-train speeds are increasing so rapidly that many railroads are operating freight trains on schedules closely approximating those of their passenger trains. However, in so doing, they are encountering serious difficulties. The increase of freight-train speeds on standard types of friction bearings has resulted in serious hot-box problems. The only certain way to eliminate hot boxes is by the use of roller bearings.

The direct financial benefits to the railroads from the use of roller bearings may be summed up by the simple statement "freedom from trouble and reduced maintenance expenses" in so far as the journal bearings are concerned. However, there are many intangible advantages which together with the direct advantages make it possible for the railroads to better perform their service to the public of transporting goods.

One of these advantages is that of relative resistance of roller-bearing-equipped freight cars in summer and in winter.

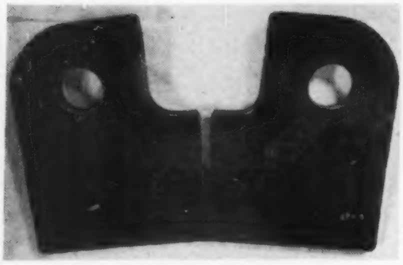
The Mechanical Division of the American Association of Railroads created a subcommittee which has worked out specifications for standard roller-bearing truck side frames and axles, and its report has been submitted to the member railroads for approval.

This roller-bearing truck side frame and one developed by Timken are discussed.

Cleavage Fractures

Development of Cleavage Fractures in Mild Steels, by A. B. Bagsar, Sun Oil Company, Marcus Hook, Pa. 1947 ASME Annual Meeting paper No. **47—A-75** (mimeographed).

The susceptibility of several types and thicknesses of mild steel of ship-plate and pressure-vessel qualities and of samples of welds to development of cleavage or brittle fractures has been determined by a new test, termed the



CLEAVAGE-TEAR TEST COUPON SUBJECTED TO ECCENTRIC LOADING AND MULTIAXIAL STRESSES

(Fracture started from a 45-deg notch whose base radius was 0.044 in. when a load of 101,000 lb was applied with an eccentricity of $4^1/_2$ in. Coupon is 6 in. deep and 1 in. thick.)

"cleavage-tear" test, in which a notched tensile-bend type of test coupon is used. The effects of notch and coupon geometries, load eccentricity, rate of loading, testing temperature, and of heat-treatments were investigated.

At temperatures below the transition-temperature range the presence of a notch of proper geometry and orientation was found to create a state of multiaxial stress which appears to expand the elastic range of steel and to raise its proportional limit almost to coincide with its breaking point. The breaking strength of rectangular sections containing a notch of the foregoing type was found to decrease, and susceptibility to cleavage fracturing to increase as the notch-root radius was decreased. Within the limits investigated, the breaking strength of steel was found to be modified by the notch geometry, this modification being practically independent of the size effect if the section was 6 in. or greater in depth. The transition temperatures for the steels investigated in the as-rolled condition were found to be about 100 F higher than those indicated by the conventional Charpy impact test, and are considered to be more nearly indicative of behavior of steels in service.

Two types of fracture were encountered, one being the brittle or cleavage type, exhibiting no appreciable deformation and lower breaking strength, and the second the shear type, exhibiting normal ductility and higher breaking strength. Fractures above the transition range were of the shear type and below that temperature range of the cleavage type, if the notch-root radii used were sufficiently small. On the basis of the test data presented, reconsideration of present factors of safety is suggested for monolithic structures with the object of safeguarding against the possibility of development of large cleavage fractures from small discontinuities, notches, or cracks. Other remedial measures for minimizing the damage of cleavage fractures, including modifications in design and material of construction, are suggested.

Firebox Design

Notes on the Design and Construction of Staybolt Locomotives, by Fred P. Huston, deceased, formerly, Mem. ASME, International Nickel Company Inc., New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-59** (mimeographed).

Improvements in design, materials, and methods in stay-bolted firebox construction for locomotive boilers offers many opportunities for designers to increase utility factor of steam locomotives. Many attempts to improve design of firebox construction failed in the past because consideration was not given to the influence of stay-bolt leakage in the cracking of firebox side sheets.

Another handicap faced by designers has been the severe limitations imposed on thickness of plates and size and number of stay bolts by existing code and safety rules. In use for many years, these rules do not take advantage of the superior properties of new materials now available What is needed is a research program to establish new stress allowances more in keeping with modern design practice and materials.

Tests made on Pacific-type locomotives showed that use of oversize stay bolts was not the answer to longer firebox life. A decrease of 39 per cent in the average life of firebox side sheets resulted when $1^1/_{16}$-in-diam stay bolts followed use of 1-in-diam bolts.

Attempts to extend service life by use of improved materials also failed. In one case, comparative tests on three different steels for firebox side sheets were used. Each locomotive was fitted with sides of different steels. In all but two cases failures occurred in both steels at the same mileage in each locomotive.

These results led to a series of tests to determine the part stay-bolt leakage played in the cracking of firebox sheets. A number of locomotives with poor service records were chosen. Some had the conventional stay-bolt construction, screwed through the sheet, hammered with ends riveted over. The others had seal-welded leaktight construction. The results were overwhelmingly in favor of the seal-welded construction.

Use of nickel-clad steel for side-sheet construction shows promise, but an increase in width of water space from $5^1/_2$ to 7 in. by offsetting the sheets failed to improve service life.

Seal welding of stay bolts has become standard practice on several roads and about 300 locomotives in this country and Canada are so equipped.

Procedures for seal welding are currently undergoing refinement. To obtain a strong metal-to-metal fitting in the screwed-stay-bolt construction, expansion of threaded end of stay bolt by use of explosives has been successfully developed. Eventually the screwed stay-bolt is expected to give way to a fusion welded fastening, a method which has been accepted by the ASME Boiler Code Committee.

The stay-bolted firebox is well suited to meet requirements of the modern locomotive boiler, but more liberal working-stress allowances than now permitted in codes and safety rules seems advisable for the higher working pressures that are so desirable for steam-turbine drives. With the use of modern materials and techniques only minor changes are needed to the conventional firebox design to win considerable economies in maintenance, reliability, and weight.

Steam Power

A Subsaturation Reheat Cycle, by W. E. Caldwell, Mem. ASME, Consolidated Edison Company of New York, Inc., New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-110** (mimeographed).

High-pressure is recognized as a prerequisite to maximum economy in steam-power production but the resulting moisture increase reduces efficiency in the wet stages and aggravates water cutting of the exhaust blades. Increasing initial steam temperature or reheating the steam during expansion is the usual compensating means for reducing the excess moisture which causes exhaust-blade deterioration.

About 12 per cent of moisture in the exhaust stages is generally considered at the economic limit in the design of steam turbines. A reduction of exhaust moisture is desirable because it increases efficiency and reduces maintenance. While an increase of initial steam temperature will reduce exhaust moisture, some form of reheat is more practical.

Since moisture conditions ordinarily occur below the 100-lb stage, this paper proposes a reheat method which uses low-pressure bleed steam in combination with hollow stationary blades or nozzle partitions currently being provided in some turbines to improve strength performance and methods of fabrication. Steam bled from the higher stage enters the top of the diaphragm passage, flows through the hollow blades to the center segment, then into the lower half of the diaphragm and on down through the lower blades to the bottom drains.

It is not intended to superheat the steam but to evaporate excess moisture as it is formed. The surfaces in the low-pressure stages are adequate and the required temperature differences can be obtained with moderate pressure differences. The engineering problem involved in introducing low-pressure steam into hollow stationary blades is a simple one. The number of stages to be heated by this method can be determined on the basis of economics but addition of heated stages upstream until the dew point is reached will increase efficiency.

The paper presents an analytical study of the advantages of the use of this method.

Evaporative reheating releases the choice of initial steam pressure from the limitation imposed by initial temperature and exhaust moisture conditions. It offers more effective moisture control than by increasing initial steam temperature. It permits building a simple two-bearing condensing turbine in a single unit for any initial pressure up to the critical with an initial temperature of 950 F or less with over-all economy excelling that of turbines now available.

The need for superalloys for abnormally high temperatures and for resisting cutting is obviated since initial steam temperature can be reduced with maintaining a dry exhaust. As this method of reheating requires no regulation, operating simplicity is assured, and compared with present practice, the method offers lower production costs with less capital investment.

An Experimental Determination of the Velocity of Sound in Superheated Steam by Ultrasonics, by James Woodburn, Jun. ASME, Rice Institute, Houston, Texas. 1947 ASME Annual Meeting paper No. **47—A-119** (mimeographed).

This paper describes the apparatus used in a particular application of ultrasonic sound and presents for the first time actual measurements of the velocity of sound in superheated steam.

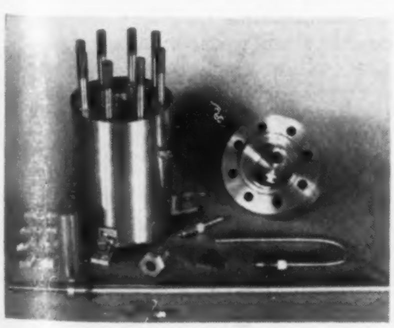
A quartz crystal vibrated electrically at its natural frequency is used as a sound source to set up a series of standing sound waves in a vertical cylinder filled with steam.

The velocity of sound is determined by measuring frequency and length of the sound waves produced. The apparatus of wave-length measurement is an acoustic interferometer. This apparatus consists of a carefully constructed cylinder $^3/_4$ in. ID with a quartz crystal at one end and a movable piston at the other. When the piston is moved to a position where the distance between the crystal and the face of the piston is an integral number of half wave lengths of the sound being produced, a sharp peak is produced in the voltage across the crystal. Frequency is determined electrically.

Results obtained by this acoustic method show close agreement with values calculated from steam tables of Keenan and Keyes.

The acoustic interferometer makes it possible to measure sound velocities with high frequencies without employment of large quantities of gas. Because a slight trace of an impurity in a gas alters materially velocity of sound in it, the apparatus can be used to detect traces of air in steam, for example. The apparatus is simple in construction and can be operated readily by laboratory technicians.

The accuracy of values obtained by use of the acoustic interferometer recommends it for determining thermal properties of other fluids, such as refrigerants, used by engineers.



COMPONENT PARTS OF ACOUSTIC INTERFEROMETER USED IN MEASURING VELCOITY OF SOUND IN SUPERHEATED STEAM

Applied Mechanics

Thermodynamic Properties of Gas Mixtures Encountered in Gas-Turbine and Jet-Propulsion Processes, by Joseph Kaye, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1947 ASME Annual Meeting Paper No. **47—A-1** (mimeographed).

The presentation of data for gas mixtures on a molal basis reduces greatly the number of tables required for calculations of processes in a wide variety of mixtures. This simplification of the tabular data is illustrated in detail by consideration of several gas mixtures and of the processes encountered in the design of gas turbines. Three tables of products of combustion of a hydrocarbon fuel with air are sufficient to permit calculations of all processes of interest with an average error of about 0.1 per cent over a large range of hydrogen-carbon ratios of the fuel and over the range of fuel-air ratios for lean mixtures. Furthermore, these three tables may be used with the same error for calculations involving mixtures of air and octane vapor as well as for mixtures of air and water vapor.

A Mechanical Analyzer for the Solution of Vibration Problems of a Single Degree of Freedom, by E. E. Weibel, Mem. ASME, University of Colorado, Boulder, Colo., N. M. Cokyucel, Marchant Calculating Machine Company, Emeryville, Calif., and R. E. Blau, University of California, Berkeley, Calif. 1947 ASME Annual Meeting paper No. **47—A-52** (in type).

A mechanical-analogy-type analyzer is described which is of relatively simple construction being limited to single-degree-of-freedom problems. Within this limitation solutions may be obtained for systems which include various types of nonlinear elasticity and of nonlinear damping. Included is a generalized solution obtained on the analyzer giving in dimensionless form the maximum displacements and forces in a system having nonlinear (linear plus cubic) elasticity and linear damping caused by a force pulse of constant magnitude and finite duration. The bearing of the results on the starting torques in nonlinear systems is indicated.

Vibration of a Nonlinear System During Acceleration Through Resonance, by R. B. Meuser, University of California, Berkeley, Calif., and E. E. Weibel, Mem. ASME, University of Colorado, Boulder, Colo. 1947 ASME Annual Meeting paper No. **47—A-53** (in type).

During acceleration of a machine through a critical speed, displacements and stresses may attain large values. For linear systems F. M. Lewis ("Vibration During Acceleration Through a Critical Speed," Trans. ASME, vol. 54, 1932, APM-54-24) and J. G. Baker ("Mathematical-Machine Determination of Vibration of Accelerated Unbalanced Rotor," *Journal of Applied Mechanics*, Trans. ASME, vol. 61, 1939, p. A-145) have studied different aspects of this problem, the former analytically, the latter by mathematical-machine methods. This paper presents a generalized solution obtained on the mechanical analyzer (Paper No. 47—A-52) for the effect of an accelerated sine-wave force on a spring-mass system having linear plus cubic elasticity and linear damping. The range of accelerations covered applies to electrically driven reciprocating machines and to other rapid starting units. Some interesting effects of nonlinearity on displacements and forces are pointed out.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Heat-Pump Installations

Comment by E. R. Ambrose[1]

Practically all of the installations which are briefly covered in the present paper[2] have been described in detail in previous articles. This fact need not detract from the value of the paper since summary design and operating data on existing installations can, in many cases, be used quite advantageously for future installations. Care must be exercised, however, in the correct interpretation of such data to prevent erroneous conclusions and deductions. Generally, more information is required than is given in this paper but quite a few references are included which enable an interested individual to pursue the subject further.

Individuals who have not been following the heat-pump development too closely may find values for the coefficient of performance given in Table 6 of the paper somewhat misleading and confusing. The coefficients of performance listed in the last column of Table 6, for the different installations, vary considerably even when using the same heat source in approximately the same geographic location. It appears that the inclusion of an explanation for these wide variations would be a valuable addition to this paper, since the coefficient of performance is by far the most important guide in judging the operation of a heat-pump system.

Those who have been following the heat-pump development during the past 10 or 15 years have long realized that standardization of test procedure and co-ordination of test results must be brought about before worth-while and reliable data can be derived from the many experimental installations now in use, and from the research and development now being undertaken on particular phases of the subject by various individuals, and by industrial and utility groups.

The Edison Electric Institute and the Association of Edison Illuminating Companies are organizing a joint heat-pump steering committee in the near future to represent all of the electric utilities in the development. One of the first duties of this committee is to make available a suggested procedure for testing heat-pump installations so that all results in the different parts of the country can be properly correlated. After the operation and performance data have been carefully analyzed and checked for accuracy, it is planned to make them available to all interested parties.

The need for such a committee has long been felt, and it is hoped that it will start to function immediately and thus eliminate to a great extent the publication of unreliable test data, resulting mainly from incorrect test procedure and from inexperience of the persons making the tests.

In spite of the great amount of publicity given the heat pump during the past year, it must be considered as still in the developmental stage in so far as residential heating and cooling units are concerned. It is true that a number of the design and operating difficulties, which have been responsible for the slow progress of the heat pump in the past, have already been solved or are now in the process of being solved. However, there are still other problems which need further investigation and study before the heat pump can expect public acceptance in the residential heating and cooling field.

[1] Air Conditioning Engineer, American Gas and Electric Service Corporation, New York, N. Y. Jun. ASME.

[2] "A Review of Some Heat-Pump Installations," by E. B. Penrod. Mechanical Engineering, vol. 69, August, 1947, pp. 639–647.

Comment by R. A. Budenholzer[3]

This paper brings together a great deal of historical and background information regarding the heat pump which is of great value to those having an interest in the subject. Also, it brings to the attention of the engineering profession the present status of the heat pump as a possible rival to other domestic and commercial heating and cooling systems.

One factor which should not be overlooked in the evaluation of the heat pump as a domestic heating unit is the availability of a suitable source of low-temperature heat energy. Since it is imperative that the source of energy be at a sufficiently high temperature level to make the coefficient of performance and consequent economy of operation attractive, the proper choice of supply is of great importance. The three most common sources are the outside air, well water, and the ground. Although the air is unquestionably a suitable source in mild climates, it is of doubtful value in the more severe climates of the middle and northern United States where the population is very great. Water would be an ideal source were it available in abundant quantities in all communities. However, the rapidly descending water table in most localities jeopardizes this source of supply where large numbers of installations might be involved.

In view of these facts, a great deal of attention is at present being centered on the use of the ground as the source of heat for small residential units. The writer has been associated with a project in which extraction of heat from the ground by an experimental heat pump, using a ground-coil evaporator, is being studied. The results to date are promising, but a great deal of research work yet remains to be done before an adequate knowledge of the ground as a source of heat supply is available. Some of the problems which remain to be solved are the following:

1 The effect of moisture content on the thermal conductivity of various soils.

2 The effect of continuous and intermittent operation for season after season on the ground temperature and available source of heat supply.

3 The effect of precipitation and surface heating during the summer season on the available heat supply during the winter season.

Another factor which is too often overlooked, but which is of major importance in achieving a high coefficient of performance, is the over-all efficiency of the electric motor and compressor combination. At present, small-size combinations having over-all efficiencies greater than 60 per cent, based upon isentropic compression of the refrigerant,

[3] Professor of Mechanical Engineering and Consultant in Thermodynamics to the Armour Research Foundation of the Illinois Institute of Technology, Chicago, Ill. Mem. ASME.

are nonexistent. The improvement of the compressor and driving electric motor is a challenge to the manufacturer which should not be overlooked if the heat pump is to prove a successful competitor in the heating and air-conditioning fields.

COMMENT BY F. W. JORDAN[4]

Applications of the heat pump with present-day equipment are unquestionably practical for many installations throughout the United States, providing they are made in accordance with good engineering practices.

Unfortunately, recent attempts by some manufacturers to exploit self-contained packaged heat pumps have not been based upon good engineering practices or common sense. Rather, they have been carried away by pure sales promotion and the idea that they have captured the ultimate in design of a salable packaged heat-pump unit. It has been the experience of the writer that there are definite limitations to the heat-pump system.

Where outside air is used as a source of heat, installations must necessarily be limited to moderate climates such as prevail in certain areas of California, Arizona, and some of the southern states. Where heat pumps utilize well water or city water, the applications will be limited to the availability of the water supply, the cost of the water supply, and, very important, the disposal of the water.

Utilizing ground heat by embedding heat exchangers in the ground offers some interesting research possibilities. This method of absorbing heat from the ground may prove practical.

It is also the conclusion of the writer that the immediate future of the heat pump lies in commercial installations rather than in domestic installations. Refrigerated air conditioning for summer conditioning has proved essential for a vast variety of commercial establishments to insure comfort and efficiency not only of the employees but to attract customers to their respective places of business. Wherever the heating load does not exceed the capacity of the refrigeration equipment for the cooling load, the application of the heat pump is practical, providing of course a suitable heat source in the form of outside air or water is available.

With modern store lighting, the tendency is to increase illumination far in excess of that considered the ultimate prior to the war. Prior to the war, four watts per sq ft was considered maximum; however, in many new stores the lighting load has reached ten watts per sq ft.

For example, in designing the air-conditioning system for Bullock's new store at Palm Springs, Calif., the actual maximum heating load is far less than the actual cooling load. Design conditions for this store are as follows:

BULLOCK'S—PALM SPRINGS

Summer design:		
Outside	110 deg dry bulb	75 deg wet bulb
Inside	85 deg dry bulb	69 deg wet bulb
Max. cooling load, Btu per hr		1800000
Well-water temperature, deg F		70
Chilled-water temperature, deg F[a]		50
Winter design:		
Outside	35 deg dry bulb	
Inside	74 deg dry bulb	
Building heat loss, Btu per hr		701000
Fresh air load, Btu per hr		567700
Total heat load (gross), Btu per hr		1268700
Heat gain from lights (205000 w), Btu per hr		571700
Net heat load, Btu per hr		697000

[a] Temperature leaving chiller.

Referring to the tabulated design conditions, it will be noted that even when the winter outside conditions are 35 deg dry bulb, inside, 74 deg dry bulb, the net heat load for the building is 697,000 Btu per hr, whereas the maximum summer cooling load is 1,800,000 Btu per hr. Note that the actual heat gain from the lights amounts to 571,700 Btu per hr.

Studies of other modern stores indicate that with the trend in modern lighting, summer air conditioning is essential to maintain working conditions and comfort conditions within the store and, by the same token, the lighting load is such that in many cases, it will take care of the heat loss in the building in winter for as much as 90 per cent of the time. These conditions, of course, are true primarily in areas with moderate winter design.

The writer believes that the domestic market is not attractive to any manufacturer at the present time, owing to the necessity of engineering installations for the locality. Due to a wide variation in climatic conditions, it is almost impossible to arrive at a design of packaged unit that will have universal acceptance, much less local acceptance. The first cost of the heat pump, as compared to conventional heating systems, utilizing coal, gas, and oil, is out of line. Reliability of the equipment has not reached that of domestic refrigeration, and the noise level of commercial equipment is above that acceptable for domestic installations, unless expensive soundproofing is utilized.

It is the writer's opinion that the market for the heat pump or reversed-cycle air conditioning, as it is commonly termed, is small, not attractive to manufacturers, but sufficiently promising to encourage further research and development.

COMMENT BY ALLEN LATHAM, JR.[5]

The historical facts and operating data given in this paper constitute an interesting and worth-while record of the development of heat pumps. Since he has made extensive reference to European practice in the use of heat-pump systems for industrial uses, such as distillation and concentration, it seems appropriate to comment on American developments in this field. During World War II, the writer's company and E. B. Badger and Sons Company developed and produced over 10,000 compression-distillation units for use by the Armed Services in production of drinking water from sea water.

Subsequent to the war, an extensive program of developing and building such equipment for production of very pure distilled water for process use in industry has progressed to the point where several plants are now nearing completion.

It is interesting to note also that the ratio of distilled water produced to electrical energy consumed, as reported for the very large Escher-Wyss unit, is substantially less than is obtained with the relatively small units manufactured by E. B. Badger and Sons Company for use aboard small naval craft. It is anticipated that the industrial units now being built will have an even higher ratio.

[4] Pacific Coast District Manager, Westinghouse Electric Corporation, Sturtevant Division, San Francisco, Calif.

[5] Charge of Engineering Development, Arthur D. Little, Inc., Cambridge, Mass. Mem. ASME.

COMMENT BY R. G. OWENS[6]

Although many people are interested in the heat pump, their reasons vary widely. The purely promotional type, of which there are not a few, asks the question: "Is it possible for me to put in one dollar and get out five?" The engineer of course is not included in this group. He is interested in seeing the heat pump developed for the betterment of mankind. The power companies are interested in the heat pump in order that it may be possible, with this load, to distribute their power more economically, the customer thus benefiting from this economy. The purely research man gets great satisfaction from being able to develop a product which, he feels sure, will lead, in time, to better and cheaper living for all.

It is natural for men who are enthused about a particular product to be a bit optimistic in their predictions for its future, even making claims for it which, when the scientific data are carefully checked, are not entirely borne out. It is suspected that in some cases which are reported in this paper, optimistic values of COP have been claimed. The author of course has only reported these claims and, in some instances, has questioned their validity.

Even with these optimistic values of COP, it appears that the heat pump for home use is still in the luxury class. It is understood that certain of the heat-pump promoters have already applied mild pressure to the utility companies to obtain special rates, which would enable them to compete with the conventional heating systems. It is the writer's, opinion that the burden lies, at least for the present, on the research engineer to develop the heat pump for greater economy. Of course the answer to this question must come from the utilities.

COMMENT BY E. H. WALTON[7]

This paper clearly shows the need for more extensive and accurate performance figures from the experience of heat-pump equipment in operation. It is understandable that for the installations of residential size such data may be difficult to obtain. However, for the larger commercial plants, as listed in Table 6 of the paper, it is reasonable to expect that fairly complete operating experience should be a matter of record, and this information should be of considerable interest to engineers designing new installations. For such figures to be analyzed and evaluated, the need for comparable reports is evident, one of the co-ordinating efforts which would be helpful to the future development of the heat pump.

In this connection, it appears desirable to mention the installation in the Administration Building of the United Illuminating Company at New Haven, Conn. The COP of 2.9, as reported in Table 6, was calculated taking into account all of the power to drive auxiliaries as well as that required for the compressors. These auxiliaries include not only well- and circulating-water pumps and zone booster pumps, but also all ventilation supply and exhaust fans and even 112 small recirculating fans located in individual-room units throughout the portion of the building which is completely air-conditioned. This therefore includes some power which would have been required with a fuel-burning heating system.

Furthermore, it should be noted that experience has proved the capacity of the heat-pump system to be greater than actually required—a condition which has been encountered on other early installations of commercial size. Although it is believed that the auxiliaries were fairly well-sized for the system as designed, it is likely that they are larger than the optimum size for maximum efficiency at the loads which have actually been experienced. For this reason alone, a redesign of this system, based upon information now available, would probably increase the over-all operating COP by at least 10 per cent, even though using individual equipment of the same efficiency.

Seven years of experience with this installation have indicated an annual average load factor, as defined in the paper, of 36 per cent.

COMMENT BY CLAUDE R. WICKARD[8]

It is felt that the author's requirement of a COP of 6 for the heat pump using 1 cent per kwhr electrical energy, as compared with a furnace burning coal at $8 per ton and operating at 65 per cent efficiency, may be somewhat conservative. In Washington, D. C., where graded stoker coal costs $10.50 per ton, if it is assumed that a stoker-fired home-operated furnace has an efficiency of 50 per cent, a COP of only 3.9 is necessary to make 1 cent per kwhr electricity competitive with coal.

It may be of interest to add that a domestic heating system along the lines of the Webber unit in Indianapolis is manufactured by the Terra Temp Company, Inc. Also, the General Engineering and Manufacturing Company has installed a heat pump in the home of George Whitlow in Glendale, near St. Louis, Mo., and had plans to be in production on similar units before the end of 1947. According to our latest information, Muncie Gear Works has shipped more than 50 units for installation.

The thermocompressor, or vapor-compression still, was used during World War II by the United States armed forces, to obtain fresh water from salt water. Thermocompression equipment for water distillation is furnished in the United States by the E. B. Badger and Sons Company, Boston, Mass., and the Cleaver-Brooks Company, Milwaukee, Wis.

The REA has followed with interest the development of the heat pump for domestic heating and cooling because of the effect it may have on power-distribution systems and on the home life of the farmer. If public acceptance of this unit becomes widespread, present estimates of electrical energy consumption will be obsolete and plans for the future must be modified.

AUTHOR'S CLOSURE

Mr. Ambrose is correct in saying that the coefficient of performance (COP) is by far the most important guide in judging the operation of a heat-pump system. However, before an authoritative committee prepares a code for testing heat-pump installations, the COP should be defined properly in order to avoid further confusion. The author would like to suggest the following definitions: (*a*) A "heat pump" is a refrigeration compressor and its driving motor; (*b*) "heat-pump system" is a heat pump plus the necessary auxiliary equipment needed for continuous air conditioning, which consumes electric energy; (*c*) the COP of a heat pump, when used for heating, is the ratio of the quantity of heat delivered to the heat equivalent of the electric energy consumed by the driving motor; (*d*) the COP of a heat-pump system, when used for heating, is the ratio of the heat delivered to the heat equivalent of the electric energy consumed by the entire system; (*e*) the COP of a heat pump, when used for cooling, is the ratio of the quantity of heat removed to the heat equivalent of the electric energy consumed by the driving motor; (*f*) the COP of a heat-pump system, when used for cooling, is the ratio of the quantity of heat removed to the heat equivalent of the electric energy consumed by the entire system.

If the foregoing definitions are accepted, an engineer can use them to advantage either in designing a heat-pump system, or in analyzing test data to deter-

[6] Illinois Institute of Technology, Chicago.

[7] Mechanical Engineer, The United Illuminating Company, New Haven, Conn. Mem. ASME.

[8] Administrator, Rural Electrification Administration, Washington, D. C.

mine the performance characteristics of the installation.[9] It should be kept in mind that in some localities the cooling load is greater than the heating load, and in such cases the COP for cooling is more important than that for heating.

The COP's given in Table 6 of the paper are not necessarily misleading. It is true that the COP's of 7.35, 2.04, and 1.5 are questionable. The mean COP is 3.35 for the nine air heat-pump systems, eight of which are in California. If these questionable values are omitted, the mean COP for the remaining six air-heat-pump systems is 3.21, and the deviation of the individual COP's from the mean is not too great. On the other hand, the mean value of the COP's is 3.38 for the five heat-pump systems using well water for the heat source; here again the deviation of the individual COP's from the mean value is not great. It should be added that the COP is 5.45 for the heat-pump system at Buenos Aires where the heat source is 66-deg F well water If this value of 5.45 is included, the mean COP for the six heat-pump systems using well water is 3.72. At New Haven, a COP of 2.9 was reported for the heat-pump system with 58-deg F well water for the heat source. This comparatively low value of 2.9 may be explained as follows: At the time the heat-pump system was designed, provisions were made in sizing the plant to provide for the necessary heating capacity in case an additional story was added to the building. The heat pump, auxiliary fans, and pumps were oversized in order to meet such a contingency. As of to date, only five of the 8-ton units have been used at one time. In analyzing the test data for this installation, it would have been wise to report the COP for the heat pump and the heat-pump system. If this had been done, the effect of using oversized auxiliary equipment would have been apparent.

Professor Budenholzer has pointed out rightly that a domestic heat-pump system should not be installed for continuous air conditioning unless a suitable heat source is available. He is probably correct in stating that the over-all efficiency of electric motor and compressor combination in the low-capacity bracket is too low to warrant the high COP's sometimes reported. Through research, the efficiencies of small electric motors and refrigeration compressors can probably be improved; if so, higher COP's will be possible.

Mr. Jordan has had considerable experience in designing commercial heat-pump air-conditioning systems, and his remarks concerning the production of package heat-pump units for domestic purposes should be given considerable attention. A package heat-pump unit designed for one climate may not function properly in another, and manufacturers of this type of air-conditioning equipment should keep this in mind. In using the earth as a heat source, for example, the entire heat-pump equipment cannot be placed in a box since the earth coil must be placed in the ground; in this respect a package unit heat-pump system differs widely from household electric refrigeration.

The domestic heat pump is so new that it is not surprising that some people expect to enter this field for manufacturing air-conditioning equipment without obtaining sufficient knowledge of the various engineering problems which must be solved before a satisfactory domestic heat-pump unit can be put on the market. Professor Owens' remarks concerning prospective manufacturers of the promotional type are indeed very timely. However, two very reputable manufacturing companies have approximately 300 commercial and domestic heat-pump package units in operation to obtain performance characteristics in order to make the necessary changes in the system where needed.

Mr. Walton has accounted for the comparatively low COP for the heat-pump system in the office building of the United Illuminating Company. It would be instructive if he would publish a complete analysis of test data on this installation, allocating the electric-energy consumption to the various motors used in driving the refrigeration compressors, pumps, and fans for the entire system. Also, the COP's for the heat pump and the heat-pump system should be reported for both the heating and the cooling seasons.

In determining comparative heating cost, the optimum efficiencies reported for various domestic furnaces were used. It is believed that these calculations are not too far out of line. A heat-pump system with a COP of 4.4 and electric energy at 1 cent per kwhr will compare favorably to heating with a good grade stoker coal at $10.50 per ton. Where coal sells for $12 per ton an electric heat-pump system should have a COP of about 3.7 with electricity at 1 cent per kwhr.

E. B. PENROD.[10]

[9] See for example the tables given in "Continuous Air Conditioning With the Heat Pump," *American Scientist*, vol. 35, October, 1947, pp. 512, 515, and 524.

[10] Head, Department of Mechanical Engineering, University of Kentucky.

Student Counseling in New York City

COMMENT BY B. G. A. SKROTZKI[11]

Members of the New York Engineers' Committee on Student Guidance are gratified to learn that members of the ASME and AIEE in Erie, Pa., have taken up the work of informing young high-school students about the nature of engineering, as described in a paper "Student Counseling," by A. H. Morey.[12] The Erie group as well as other members of the engineering profession will be interested to know that our group (New York City) has been carrying on this work for the last ten years and is still going strong.

The NYECSG comprises over 90 members from the Metropolitan Sections of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, and the American Institute of Chemical Engineers. Our committee is sponsored by the Engineers' Council for Professional Development, but in effect works as an independent group. Expenses are paid through donations to committee funds by the Metropolitan Sections of the professional societies.

The low percentage of freshman ultimately graduating from engineering schools motivated the formation of the New York committee. Our principal aim is to provide information to high-school students about the engineering profession, enabling them better to evaluate their own aptitudes and inclinations. The committee definitely avoids "selling" the profession to students. It is especially anxious to advise students who do not possess the needed basic aptitudes to prepare themselves for some other work than engineering.

Usually five members, one from each society, make each visit to the high schools. One of the visiting group acts as lead speaker covering the engineering profession as a whole, personal aptitudes needed in an engineer, schooling of an engineer, practical training of an engineer, and major functions of engineering such as planning and design, construction, operation and research. Each of the visiting members then gives a short talk on the fields covered by his profes-

[11] Mem. ASME. Secretary, New York Engineers' Committee on Student Guidance.

[12] MECHANICAL ENGINEERING, vol. 69, no. 12, December, 1947, p. 1016.

sional society. Questions are then invited from the students which are answered by the committee members for the benefit of all students present. The session concludes with the meeting breaking up into smaller groups with each committeeman answering questions bearing on more personal problems of the student. Meetings last about two hours.

School authorities have been wholehearted in their co-operation to get the engineering story before the students. To further this co-operation meetings are generally held annually and are jointly attended by our committee members, high-school superintendents and guidance counselors, and local engineering-school faculty members. At this annual meeting the general problems of student guidance for the potential engineer are explored from all angles to everyone's benefit. These meetings are further enhanced by being coupled with a luncheon or dinner facilitating intense discussions among those attending.

Our group is now expanding its service to cover the metropolitan area as well as New York City. To render this extended service additional personnel are being recruited in order to keep the visiting load per member at a reasonable level. Practically all of our visits take place during business hours, so the time given means a sacrifice on the part of the visiting members. Their earnest interest in this endeavor is attested by the long tenure of membership in the group now in the eleventh year of its existence. Here is the record of the work done in the past in terms of high-school visits made annually:

Year	No. of visits	Year	No. of visits
1937–1938..	3	1942–1943..	22
1938–1939..	13	1943–1944..	17
1939–1940..	22	1944–1945..	16
1940–1941..	27	1945–1946..	18
1941–1942..	24	1946–1947..	26

On the basis of an average attendance of 50 per meeting, our group has served approximately 9400 high-school students during the last 10 years.

Manufacturing Laminated Tennis Rackets

COMMENT BY R. R. SMITH[13]

The author has thoroughly covered the manufacture of tennis rackets,[14] the historical background giving a resumé of the changes in style and shape which have had so much to do with the speed of the game.

Mention was made of the steel racket with steel strings which did not meet with widespread favor among the leading players. The author also showed a new development in the form of a magnesium racket. This racket is so new its merits have not been passed upon by ranking players. A great deal of study has been devoted to procurement of proper lumber and much attention has been given to manufacturing methods with the idea of producing an article made of wood of uniform quality. In the early days of racket manufacture better grades of ash, hickory, and oak were available. Now that the original grades of stock are not available, laminated construction has come to the fore, and with it detailed study of proper adhesives.

The paper shows the effort spent by a sporting-goods company in seeking to so control its product that each piece shall be of like grade; an extremely difficult accomplishment where natural raw materials are used. Precision is stressed to a degree not thought possible outside the metalworking trades.

[13] Pressed Wood Corporation, Gardner, Mass.

[14] "Manufacturing Laminated Tennis Rackets," by J. N. Tynan, MECHANICAL ENGINEERING, vol. 69, September, 1947, pp. 735–738.

The Habit of Community Service

TO THE EDITOR:

Dr. Llewellyn Cooke points clearly to the engineer's disinterest in community service,[15] in MECHANICAL ENGINEERING for December, 1947. He is keenly aware of the danger to our way of life when those groups who have the opportunity of a higher education use this education almost entirely for the development of special knowledge, and turn their backs on those general studies which would show them the relation between their specialty and the other activities of mankind. Harvard, in its "Report on General Education in a Free Society," has recognized this error and is beginning to require all of its students to take certain basic courses, thus partially replacing the elective system.

It is interesting to see what these courses are. First in the list is a course called "Humanities 1*a*—Homer, The Old Testament, Plato." Next comes "Humanities 1*b*—The New Testament, Dante, Shakespeare." Is it possible that the way of life we have built up here in America rests, in its foundations, on belief in the brotherhood of man and the fatherhood of God? Does the real incentive for community service come from the feeling in the individual that he has a transcendental obligation to serve the community in which he lives, in every way he can?

And as concerns his advancement in the world, is it true that the engineering student who learns to see need beyond his specialty, and develops skill in serving a variety of needs, is the one who rises to the most responsible executive positions in his professional field?

These fundamentals have been forgotten by too many of us teachers of specialties. And we cannot teach community service until we, the teachers, regain our own deep convictions that broad skills in serving others, and the habit of doing so, cannot safely be dropped in favor of specialized training. The catastrophe which came twice to Germany—the land of specialists—is a clear example of the danger. The survival of Britain shows the essential place of religion and of competitive sports in the development of character, both individual and national.

The reversal of the trend toward specialism has set in. Gradually our college faculties will be made up of men with the broad outlook. But for the present, the encouragement of faculty members who have escaped "superspecialism" by such writings and examples as those of Dr. Cooke can save many a student from the blindness of overspecialization and many a community from abandonment by its most highly trained citizens.

GILBERT E. DOAN.[16]

[15] "The Habit of Community Service," by M. L. Cooke, MECHANICAL ENGINEERING, vol. 69, no. 12, December, 1947, pp. 1017 and 1018.

[16] Department of Metallurgical Engineering, Lehigh University, Bethlehem, Pa.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Gas-Turbine Construction

Gas-Turbine Construction. By R. Tom Sawyer. Prentice-Hall, Inc., New York, N. Y., 1947. Cloth, 6 × 9 in., 411 pp., illus., $7.

Reviewed by Arthur M. G. Moody[1]

R. TOM SAWYER, the well-known author of "The Modern Gas Turbine," has gone a step further in his new book, "Gas Turbine Construction." Where he was previously concerned with the potentialities of gas turbines, he is now presenting actual achievements.

Essentially this book is a compilation of documents relating to gas-turbine construction and operation. Some of these are ASME papers, others are based on articles from technical journals, while a few are taken from manufacturers' service manuals. In all cases the material is authoritative. For example, the chapter on "Operating Experience With Gas Turbines" is a revision of an ASME paper by A. E. Pew, Jr., while the chapter "British Aircraft Gas Turbines" is an abstract of Dr. H. Roxbee Cox's fine lecture. The author has been meticulous in giving credit to the original sources.

The book is in three parts. The first, on heavy equipment, deals with Allis-Chalmers and Brown-Boveri units, the Elliott Marine unit and the Escher-Wyss Closed-Cycle Plant. The second covers Turbochargers, as built by American Locomotive, Elliott, General Electric, and Wright Aeronautical. The third deals with aircraft gas turbines, and contains sections on American, British, and German types.

There is a wealth of photographs, sketches, drawings, curves, and tables, which give the book tremendous "eye-appeal," and present information which will answer many questions about gas turbines.

While the book appears to be largely free from mistakes, attention might be called to one on page 221, since the error could be misleading to the uninitated. In the last line, the figure 228 should read 67.6, giving an efficiency of under 18 per cent instead of practically 60 per cent.

By the nature of the book it is not handy for reference purposes, because each section is presented substantially in the words of the original author, with a minimum of editing. Consequently, differences of terminology appear, as well as differences in outlook and approach. It would have been helpful if Mr. Sawyer had added at least a little editorial comment to tie some of the loose ends together. To some extent the role of such comment could have been filled by a well-conceived index.

For example, anyone desiring to compare the types of materials used in different applications would welcome at least a brief discussion by the author. Failing this, he would be reasonably well satisfied if the index had a heading "materials," with complete subindexing. Lacking even this, he would still feel better if individual materials were adequately indexed. Unfortunately, they are not.

One further shortcoming: Because he has adhered almost exclusively to formal reports, articles, or manuals, the author has missed some developments. The De Laval marine unit, for instance, has never been completely described in a published paper, but enough information has appeared to permit at least a brief description.

All this may sound ungrateful. Mr. Sawyer has actually done something well worth doing. He has prepared a tremendously interesting book, and one which may be the best that could be done without materially delaying publication. If one wishes that he had taken a little longer and done a little more, he might well ask who is to say where to stop.

[1] Elliott Company, Jeannette, Pa. Mem. ASME.

Industrial Health Engineering

Industrial Health Engineering. By Allen D. Brandt. John Wiley & Sons, Inc., New York, N. Y., 1947. Cloth, $5^3/_4$ × 9 in., 395 pp., 164 figs., $6.

Reviewed by H. W. Heinrich[2]

THE phrase "industrial health engineering, selected as a title for this book, is not yet in common use, nevertheless it is fully descriptive of the text. The reader appreciates at once, from both preface and chapter content, that while maintenance of good health is the author's primary objective, he deals strictly with the engineering approach.

Seldom has this reviewer seen in one volume a more compactly assembled, well selected, and easily read grouping of related data in a field so needful of just such information. Indeed, this book may be an important factor in the more complete recognition of industrial health engineering as a specialized profession.

Typical of the health hazards featured in the text are those arising from excessive concentrations of dusts, fumes, mists, gases, and vapors; exposure to high, low, or rapidly changing temperatures, exposure to high humidity, improper sanitary conditions, radiant energy, inadequate illumination, and noise.

The author is to be complimented on his arrangement. In logical sequence, following a preface in which the objectives are clearly defined, Chapter I treats of "Industrial Atmospheric Contaminants and Their Industrial Hygiene Significance." Then follow chapters on practical methods of evaluating health hazards and on the principles and methods of control. Additional chapters are devoted to the design of ventilating and exhaust systems, including the hoods, ducts, traps, collectors, and accessories. Special chapters deal with the measurement of air flow, respirators, and protective clothing, heating and air conditioning, radiant energy, illumination, noise and sanitation. Stated in another way, the arrangement first points out what the industrial health hazards of major importance are, then describes how they may be found and evaluated, and finally suggests practical ways and means of controlling them.

Typical of the care taken to provide complete information is the sixteen page table of occupations indexed to their corresponding specific health hazards. Approximately one thousand occupations are listed alphabetically from abrasive workers to zoological technicians. This

[2] Assistant Superintendent, Engineering and Inspection Division, The Travelers Insurance Company, Hartford, Conn. Mem. ASME.

table is properly preceded by one covering atmospheric contaminants and by a table of health hazards.

The principles of control are well expressed in Chapter II under the headings "Eliminating the Source of Contamination," "Prevention of Contaminant Dispersion," and "Protecting the Worker."

But it is in the chapters dealing with design and with specific control methods that the book best illustrates its true worth. Tables, charts, sketches, and formulas, examples and references are given profusely wherever of interest and value but they are subordinate and supplementary nevertheless to the fully descriptive and explanatory text itself. It is evident that the questions and problems of the designer, owner, and operator have been anticipated and answered.

This book is of value as a text for instructors and students of industrial health engineering, and especially for the designers, owners, and operators of industries where health hazards exist. Safety and health inspectors and industrial physicians will find much in it of interest and usefulness. It would not be out of place to describe it as a handbook or reference, for plant engineers, hygiene and sanitary engineers, and to the designers, engineers, and erection heads of equipment manufacturers and of construction and engineering concerns.

The Guarantee of Annual Wages

THE GUARANTEE OF ANNUAL WAGES. By A. D. H. Kaplan. The Brookings Institution, Washington, D. C., 1947. Cloth, $5^1/_4 \times 8$ in., 269 pp., \$3.50.

REVIEWED BY ARTHUR S. THORNBURY[3]

IN 1944 the Steel Workers (CIO) demanded a guarantee of full-time pay for each week of their contract whether or not work was available. Subsequently other large CIO unions followed suit and the guaranteed annual wage soon became a popular controversial subject.

Unfortunately, the union's demand for a negotiated or legislated industry-wide guaranteed wage has been too often confused with the voluntary plans supported by a few individual employers such as, Hormel, Procter and Gamble, and Nunn-Bush. There was, then, a real need for a factual analysis of the implications of this new type of guaranteed wage. Dr. Kaplan has filled this need with a careful study which is based on facts and logic, shorn of emotional thinking.

Dr. Kaplan emphasizes that the regularization of employment has always been a major aim of management. In fact, many employers, chiefly in the consumer-goods lines, have enjoyed a large measure of success in this respect. A few of these have made formal commitments in the form of a wage-security plan. The important fact is, however, that the achievement of stability preceded the commitment whereas the CIO argues that the commitment will in itself bring about stability. In other words, according to the CIO, if everyone is guaranteed full pay, whether they work or not, unemployment will be banished and the guarantee will be painless. It is this aspect of the guaranteed wage which Dr. Kaplan considers the most dangerous and he devotes a considerable part of his book to explaining its shortcomings.

Equally important is his analysis of the attitude of organized labor toward the guaranteed wage. Contrary to popular belief, many labor leaders, particularly of the AFofL group, are skeptical if not opposed to the type of economic organization that would be required if guaranteed wages become widespread. The conflict between freedom and opportunity, on the one hand, and security on the other, is not easily decided in favor of security at any price. These leaders also see in the guarantee a threat to higher wages, seniority, craft lines, and collective bargaining free of government regulations.

Shortly before Dr. Kaplan released his book, the Advisory Board of the Office of War Mobilization and Reconversion transmitted to the President an official investigation of the guaranteed wage. Judging from the content of this Report the authors were more interested in promoting their conception of what unemployment compensation should be than in exploring the issues raised by the demand for a guaranteed wage. In any event, they concluded that unemployment compensation and guaranteed wages should be integrated so that the unemployed individual would receive *full pay* for not working—part of which to come from unemployment compensation and part from the employer's guarantee fund. Dr. Kaplan very ably dismissed this suggestion by pointing out that the two are completely incompatible. Unemployment-compensation benefits are purposely set at a level which makes unemployment unattractive and requires the unemployed individual to seek and accept other work if it is available, whereas no reasonable individual would expect a guaranteed worker receiving full pay for not working to look for or accept another job. In other words, one guarantees that a laid-off worker will look for work, whereas the other guarantees that he *will not* look for or accept other work. Dr. Kaplan makes it evident that any suggestion to combine the two, namely, unemployment compensation and guaranteed wages, is naive, to say the least.

The reviewer could give no better recommendation of Dr. Kaplan's book than to quote from a review article by Herman Feldman[4] which appeared in the December, 1947, issue of the *American Economic Review* in which he states "It is a forthright, hardheaded appraisal. It concentrates on the main issues, sets them forth clearly and readably and deals with them thoroughly."

[3] Social and Economic Relations, General Motors Corporation, Detroit, Mich.

[4] Formerly Professor of Industrial Relations in the Amos Tuck School of Business Administration, Dartmouth College; died on October 16, 1947.

Study of Missiles

THE STUDY OF MISSILES RESULTING FROM ACCIDENTAL EXPLOSIONS—A MANUAL FOR INVESTIGATORS. By Crosby Field. The American Society of Mechanical Engineers, New York, N. Y., 1947. Paper, $8^1/_2 \times 11^1/_4$ in., 61 pp., 49 figs., \$1.50.

REVIEWED BY LEVIN H. CAMPBELL, JR.[5]

IN preparing the manuscript for the pamphlet, "The Study of Missiles Resulting From Accidental Explosions," Colonel Crosby Field has made a very real contribution for the future safe operation of plants engaged in the manufacture and handling of explosives. The great detail of the work described by Colonel Field in the investigation of an explosion was necessary to determine the cause of any explosion. Once ascertaining the cause with definiteness, the necessary steps could be at once instituted in all other explosives' installations to prevent a similar occurrence.

To watch the work of the author and his assistants in examining and analyzing the evidence available after an explosion gave one a great sense of security in knowing that here were a group of men who could and would determine the cause.

A president of a great company, speaking of the very few explosions in our plants, and of our enormous Ordnance ammunition loading and handling problem, used to say to me, "General, you

[5] Executive Vice-President, International Harvester Company, Chicago, Ill. Hon. Mem. ASME.

are living on borrowed time," and so we would have been had it not been for this devoted group of men who composed the organization of the Safety and Security Branch of the Ordnance Department.

In late June of 1942, shortly after I was made Chief of Ordnance, I realized the vital necessity of safety of operation of our explosive and loading plants throughout the country and called Colonel Miles by long distance, and later found him in the hospital. Very shortly he was released and I requested him to set up the Safety and Security Division of the Department. He quickly recruited a strong staff and affiliated with various associations and industries throughout the country, and solicited their help in our safety problems.

Throughout the war, which was a period of "streamlining," "unification," "tying-together," etc., various attempts were made to emasculate this division. However, when attention was called to the extremely hazardous nature of the work and of the exact "know how" required to operate with safety, these various efforts were successfully turned back. No one seemed to want the responsibility when the danger was pointed out.

A method was worked out whereby all plants were at once notified and at once introduced corrective measures as investigation of any one explosion proceeded. In other words, there was no such thing as waiting until the whole survey was completed, tabulated, checked, and approved. When a fact was established, it was at once transmitted for use in helping to prevent a similar explosion in other plants.

Figures compiled by the National Safety Council show there was only one other industry in the country safer for an employee to work in and that was the ladies' garment industry—a truly remarkable record of the tremendous advance over the situation prevailing throughout World War I!

So to these men who made such a record possible, headed by Colonel Miles, Colonel Gerber, and Colonel Field, the thanks of the Army and of the nation are due!

Scientific Management

SCIENTIFIC MANAGEMENT, comprising Shop Management, The Principles of Scientific Management, and Testimony Before the Special House Committee. By Frederick Winslow Taylor. With a Foreword by Harlow S. Person. Harper & Brothers, New York, N. Y., 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 16, 14, 207, 144, and 287 pp., illus., $5.

REVIEWED BY EDWARD H. HEMPEL[6]

THE republication of these works is as truly a most distinguished contribution to the science of management as was their first publication during the early years of this century. It should not be overlooked that thereby writings are kept alive which are considered in the entire world as the first methodical presentations in the field of management and have become the very beginnings and foundations of a new science.

It is further gratifying that the Foreword to the new edition gives the biographical data of Mr. Taylor needed to fully understand the texts, and that the Foreword was written by Dr. Harlow S. Person, who during a long and most distinguished career has been the main apostle of Taylor's ideas on Scientific Management, which basically aims to create a maximum of production for the greatest benefit of all concerned and suggests new ways of achieving this goal.

The writings of Taylor contained in this volume, or at least parts thereof, have become known not only in every English speaking country, they were also published in form of translations in German, French, Swedish, Czech, Spanish, Russian, and other languages. In most foreign Universities where management was taught, the students were required not only to know about, but actually to read and study these writings. Scientific societies, and even government agencies spread the new knowledge through special committees among engineers, factory managers, and hundred thousands of men interested in management. They used and still use it in their daily work.

If it is really intended—as President Truman's Commission on Higher Education recommended—that the great body of American youth be educated not only in the very elementals required for getting a job in some profession or industry, but also to recognize the interdependence of all people, to understand the ideas of others, to express one's own effectively; and if higher education is to be made to educate men and women to participate best prepared in the important activities of national and international scope, the thorough study of Taylor's ideas should be required from everyone who intends to participate in any kind of management here or abroad. "It is essential today that education come decisively to grips with the worldwide crisis of mankind."

Taylor, in expressing his ***fundamental ideas on management***, as Dr. Person points out, did not use the systematic style in which college textbooks are written in our days. Yet, the careful searcher after truths will find much clearer language and more food for serious thought and fundamental thinking on management in these three treatises, than he is likely to find in some of the much wordier books on management that are composed today. And anyone who cares to do some systematizing of his own, can do it readily, if he will try to remember what Taylor says on planning, organizing, operating, and controls; he will thus acquire a truly excellent fund of just that kind of basic knowledge which he needs to appraise his own thinking on management matters and that of others, anywhere, and at any time.

True, many of the ***devices, techniques, and procedures***, which Taylor recommended for application in management more than thirty-five years ago, are no longer as applicable as they were when proposed. Times have changed and better methods have been developed. But this the intelligent reader will gladly grant, and he will treasure the book just the same for its true and everlasting values.

[6] Adjunct Professor, Industrial Engineering, Graduate Division, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Chairman, Small Plants Committee, ASME.

Books Received in Library

DAVISON'S TEXTILE BLUE BOOK, United States and Canada. Eighty-second year, July, 1947, handy edition. Davison Publishing Co., Ridgewood, N. J., 1947. Cloth, 5×8 in., 1298 pp., tables, maps, $5.75; office edition, $8.25; executive's and salesmen's Directory (mills only) $4.50. This standard directory contains the usual information concerning mills of the textile industry, covering cotton, woolen, rayon, silk, and jute goods, and those using the processes of knitting, dyeing, and sanforization.

DICTIONARY OF MACHINE SHOP TERMS. By A. C. Telford. American Technical Society, Chicago, 1947. Paper, $3 \times 5^1/_4$ in., 292 pp., $0.75. All the terms with which a mechanic should be familiar in order to pursue his trade effectively are briefly defined in this small volume. A number of words and terms not directly related to shopwork are included or their value in general use.

INDUSTRIAL ACCOUNTING, Complete Course. By S. W. Specthrie. Prentice-Hall Inc., New York, N. Y., 1947. Cloth, $6 \times 9^1/_4$ in., 395 pp., tables, $5.35. Emphasizing the processes and executive uses of industrial accounting, this volume may be used as a text by business administrators, engineers, and engineering students. Basic accounting principles and bookkeeping procedure are discussed in the

early chapters. The main features of corporation accounting are then presented, followed by a group of chapters devoted to cost-accounting theory and procedure. How to use the accounting data in administering a business is stressed throughout the book, and the concluding chapters deal with the executive uses of the accounting data for the control of business expense, measurement of the operating results, and formation of business policies.

INTRODUCTION TO MECHANICS. By J. W. Campbell. Pitman Publishing Corporation, New York, N. Y., and London, England, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 372 pp., illus., diagrams, charts, tables, $4.50. The seventeen chapters of this text cover the field of elementary mechanics from rectilinear kinematics [illegible] gravitation and Lagrange's equations. [illegible]ble chains and cables are included, and the whole of particle dynamics is treated in one chapter. Calculus methods are freely used throughout, with recourse to the vector calculus where its particular use is advisable. The most important of the brief mathematical appendixes is the one discussing the principles of computation with particular attention to the handling of significant figures.

MACHINERY'S HANDBOOK. By E. Oberg and F. D. Jones. Thirteenth edition. Industrial Press, New York, N. Y., sole distributors for the British Empire: Machinery Publishing Co., Ltd., Brighton, England, 1946. Cloth, $4^{1}/_{2}$ × 7 in., 1911 pp., diagrams, charts, tables, $6. This standard annual reference book provides essential data and information on machine design and shop practice for the mechanical engineer, draftsman, toolmaker, and machinist. New material includes recent or revised engineering standards as well as additional developments reflecting current designing and manufacturing practice. As is customary, the extensive technical and mechanical data are presented in tabular form for convenience of use. Material concerning metallurgical, hydraulic, and other allied fields is given, and the whole compilation is covered by a thirty-page index.

MATHEMATICAL THEORY OF ROCKET FLIGHT. By J. B. Rosser, R. R. Newton, and G. L. Gross, McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 276 pp., illus., diagrams, charts, tables, $4.50. Originally prepared as a report to the Office of Scientific Research and Development on wartime laboratory research, this volume has now been issued with the addition of a considerable amount of expository material. A simple explanation precedes the mathematical part of each section to provide a general idea of rocket flight. The book is therefore useful both as a handbook for the trained scientist with no previous experience in the field and a text for the reader with little scientific training. A bibliography and a glossary of the symbols used are included.

MECHANICAL LABORATORY METHODS. By F. W. Keator. Fifth edition. D. Van Nostrand Co., Inc., Toronto, Canada, New York, N. Y., and London, England, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 380 pp., illus., diagrams, charts, tables, $4.50. Intended for use inco nnection with undergraduate laboratory courses, this volume contains four parts dealing with the testing of instruments, analysis of combustion, the testing of power-plant units, and other tests. Fundamental principles are presented in such a way that the student may apply them to specific cases. This fifth edition is only slightly different from its predecessor. The abridged tables of properties of steam and ammonia have been deleted, and a few new items added to the section on instruments.

MECHANICS. By J. C. Slater and N. H. Frank. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 297 pp., diagrams, tables, $4. The first of several volumes intended to replace the author's "Introduction to Theoretical Physics," this book emphasizes the topics important to mechanics, and those which make the study of mechanics the fundamental basis of all theoretical physics. Particle dynamics, problems of oscillation, vibration, wave motion, elasticity, and hydrodynamics are treated. Modern mathematical methods, such as ordinary and partial differential equations, vector analysis, Fourier series, and differential vector and tensor operations are used. Appendixes contain the mathematical background for these methods for the use of those familiar with calculus and differential equations.

MODERN DIESEL. By O. F. Allen. Prentice-Hall, Inc., New York, N. Y., 1947. Cloth, 6 × $9^{1}/_{4}$ in., 268 pp., illus., diagrams, charts, tables, $5. Presenting the history and background of the Diesel engine, this volume relates its evolution from the first, heavy, awkward-looking machine to the lightweight, beautifully designed, modern, Diesel. Essentially descriptive, the text presents no design information, but utilizes some 185 illustrations to show the accomplishments of the early days, the modern Diesels, and their applications on land, in the air, and on the sea.

MODERN GAS TURBINE. By R. T. Sawyer. Second edition. Prentice-Hall, Inc., New York, N. Y., 1947. Cloth, 6 × $9^{1}/_{4}$ in., 224 pp., illus., diagrams, charts, tables, $4. Prepared for the use of those interested in the development and applications of the gas turbine, this volume contains fundamental principles of operation, a graphic description of the inventions concerned, and an account of recent uses as supercharger and prime mover. This second edition covers the same material as the first with the addition of material on jet propulsion in the rewritten chapter on the gas turbine as an aircraft prime mover. An appendix of questions on the material in each chapter has been added. There is a bibliography.

NONFERROUS PRODUCTION METALLURGY. By J. L. Bray. Second edition. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 587 pp., diagrams, charts, tables, $6. This volume first treats the general subjects of metal ores, smelting, slags, and fluxes, then deals with the important nonferrous metals individually. The metals of secondary importance are considered, and this second edition introduces a chapter on the use of physical chemistry in metallurgical processes. Reference lists are found at the end of each chapter. The book is intended as a college text for students in metallurgical engineering.

NONMETALLIC INCLUSIONS IN STEEL. By M. Baeyertz. American Society for Metals, Cleveland, Ohio, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 135 pp., illus., diagrams, charts, tables, $3. Surveying the nature and origin of the common types of nonmetallic inclusions, this volume also contains a few of the methods that may be used to study them. It is not a complete coverage of the subject, nor a history of the development, but rather an introductory text for the beginner. The origin of inclusions in ingots, the formation of inclusions in subscales, and the effect of rolling and forging on inclusions are discussed. References to periodical literature are given.

PRACTICAL RULES FOR GRAPHIC PRESENTATION OF BUSINESS STATISTICS. By L. E. Smart and S. Arnold. Bureau of Business Research, College of Commerce and Administration, Ohio State University, Columbus, Ohio, 1947. Cloth, 6 × $9^{1}/_{4}$ in., 89 pp., diagrams, charts, tables, $2. Presenting in a clear and concise manner the essential rules for current construction of the most widely used types of business charts, this volume also contains forty examples which illustrate the application of the rules. Alternative practices are not given, but rather, basic instructions for making charts in accordance with generally accepted standards. Procedure outlines and sample charts are mainly used.

PRECISION WORKSHOP METHODS. By H. J. Davies. Second edition. Longmans, Green and Co., New York, N. Y.; Edward Arnold & Co., London, England, 1946. Cloth, $5^{1}/_{2}$ × $8^{3}/_{4}$ in., 324 pp., illus., diagrams, charts, tables, $5. Describing the principles upon which precise work depends, this volume treats the methods used in machine work. It is assumed the reader has a knowledge of machine tools and processes, as these are not described in detail. This second edition introduces a chapter on surface finish and adds recent material to the list of references. Discussions of machinability and of limit systems are included as well as machine-shop procedures.

RECORDS AND RESEARCH IN ENGINEERING AND INDUSTRIAL SCIENCE. By J. E. Holmstrom. Second edition, revised and enlarged. Chapman & Hall, Ltd., London, England, 1947. Cloth, $5^{1}/_{2}$ × $8^{3}/_{4}$ in., 366 pp., diagrams, charts, tables, 21s. Of interest to those who use technical knowledge in their work, this volume shows how to obtain information concerning the work the rest of the world is doing in any field. It shows how data may be collected from technical sources, how to integrate facts and ideas, and how to transmit these facts and ideas to those who need them. Other topics discussed are the nature and methods of technical science, the principles of technical translation, and the various organizations, particularly British, that issue publications themselves or abstract the work of others.

ROTARY VALVE ENGINES. By M. C. I. Hunter. Hutchinson's Scientific and Technical Publications, London, England, New York, N. Y., Melbourne and Sydney, Australia, Cape Town, South Africa, 1946. Cloth, $5^{1}/_{4}$ × $8^{1}/_{2}$ in., 216 pp., illus., diagrams, charts, tables, 21s. The author describes the general principles and applications of rotary valves in detail and draws comparisons between them and the poppet-valve for use on internal-combustion engines. The development of the rotary valve up to the present time is also discussed with descriptions of various rotary and semirotary systems applied to various types of old and modern engines—steam, gas, and gasoline. A brief final chapter presents the author's conjectures on the future development of the rotary valve.

SCALE MODELS IN HYDRAULIC ENGINEERING. By J. Allen. Longmans, Green and Company, London, England, New York, N. Y., Toronto, Ontario, Can., 1947. Cloth, $5^{1}/_{2}$ × $8^{3}/_{4}$ in., 407 pp., illus., diagrams, charts, maps, tables, $8.50. This book presents a survey of the techniques, advantages, and limitations of hydraulic model experiments. "Dynamical similarity" and its general implications in fluid mechanics are discussed, and scale-model investigations of river problems are described. Two classes of problems are considered: the one, involving only the flow of water between or over fixed boundaries; and the other, in

which the phenomena of erosion and accretion occur. Detailed references to the sources of data are included.

SCIENCE IN PROGRESS. (Society of the Sigma XI Devoted to the Encouragement of Research in Science. National Lectureships 1945 and 1946.) Fifth series. By F. B. Jewett and others, edited by G. A. Baitsell. Yale University Press, New Haven, Conn., 1947. Cloth, 6 × 9½ in., 353 pp., illus., diagrams, charts, maps, tables, $5. Beginning with a discussion of the future of scientific research in the postwar world, this fifth volume contains reports of recent major investigations in widely varied fields. The present knowledge of the earth's center, the development of the betatron, and summation of the progress in catalysis research are considered. Over one half of the book is devoted to various phases of biology.

SELECTED TECHNIQUES OF STATISTICAL ANALYSIS for Scientific and Industrial Research and Production and Management Engineering. By the Statistical Research Group, Columbia University. Published by McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × 9¼ in., 473 pp., charts, tables, $6. This book discusses a series of problems which occur frequently in planning, analyzing, or interpreting quantitative data, and explains various techniques appropriate to these problems. It describes the statistical approach to a problem, expounds the theory that can be brought to bear upon it, and points out the features of the problem that determine the relevance of the theory. Detailed computational procedures are given, and the interpretation of results is illustrated.

STEAM AND GAS ENGINEERING. By T. E. Butterfield, B. H. Jennings, and A. W. Luce. Fourth edition. D. Van Nostrand Co., Inc., New York, N. Y., 1947. Cloth, 6 × 9¼ in., 588 pp., illus., diagrams, charts, tables, $6. This new edition follows the policy of the previous ones in giving the latest facts and best procedures in elementary steam and gas engineering. The considerable revision includes a shifting of the order of presentation of material for a more logical approach; the work on steam turbines is expanded, while the treatment of reciprocating engines is further condensed; and the chapters on thermodynamics, gas properties, and gas cycles have been enlarged. A new chapter on the gas turbine has been introduced. The text provides a full treatment of heat-power engineering for students taking only one heat-power course, or an introductory course for those specializing in the field.

TABLES OF SPHERICAL BESSEL FUNCTIONS, prepared by the Mathematical Tables Project, National Bureau of Standards, Volume 2. Columbia University Press, New York, N. Y., 1947. Cloth, 7¾ × 10¾ in., 328 pp., tables, $7.50. The major part of the present volume is devoted to tables of the spherical Bessel functions $\sqrt{\pi/2X}\, J_n(X)$, for $\pm n$ ranging from 29/2 to 61/2 with from 7 to 10 significant figures. This set of tables complements those previously published for $\pm n$ ranging from 1/2 to 27/2. A discussion of the properties of these functions and the computation methods used also appeared in the previous volume; both volumes contain interpolation methods and notes on their respective tables.

TECHNICAL AERODYNAMICS. By K. D. Wood. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × 9¼ in., 472 pp., illus., diagrams, charts, tables, $5.50. As in the first edition, the purpose of this book is to enable the student to use published technical information on aircraft components to calculate the performance and stability of airplanes and helicopters. Basic aerodynamic characteristics, airplane performance, and flight testing, and stability and control factors are discussed in detail. This second edition has been considerably revised with emphasis on high speed and compressible flow. A large section of technical-data tables and charts is appended.

TECHNOLOGY OF INDUSTRIAL FIRE AND EXPLOSION HAZARDS. Two volumes. By R. C. Smart. Chapman & Hall, Ltd., London, England, 1947. Cloth, 5½ × 8¾ in., illus., diagrams, charts, tables; vol. 1, 202 pp.; vol. 2, 184 pp., 16 s each volume. The broad coverage of these two volumes should make them of interest in a wide field of industrial and insurance work. Fire wastage and research are dealt with in volume 1, as well as the thermal reactions of materials and fire risks with agricultural products, coal, industrial fuels, and gases. Hazards with light alloys, light-alloy dust explosions, and explosive dusts produced in industry are considered. New materials, techniques, and processes are discussed in volume 2. Dangers due to toxic gases and the use of self-contained breathing apparatus are examined, while electrical fires and explosions, due to static electricity and lightning are given close attention. Examples of actual fires and explosions are given throughout the book.

THEORY OF MATHEMATICAL MACHINES. By F. J. Murray. King's Crown Press, Morningside Heights, New York, N. Y., 1947. Stiff paper, 8½ × 11 in., 116 pp., diagrams, tables, $3. In presenting a comprehensive discussion of basic principles, the fundamental requirements of both digital and continuous mechanisms are considered with the mechanical and electronic methods for meeting them. An operational approach to the general question of the solution of mathematical problems by machines is proposed. Apart from this, the book is devoted to such mathematical instruments as the planimeter and integraph. Modern devices for the same purposes, based on photoelectric techniques, are also studied.

TRANSMISSION BELTING AND BELT DRIVES. By H. S. Jude. Trade & Technical Press, London, England, 1947. Cloth, 5¼ × 8½ in., 322 pp., diagrams, charts, tables, 30s. Following a general introductory chapter is a discussion of power losses, the drive layout, and application rules. Leather, rubber, balata, solid woven hair, and cotton belts are discussed, including belts of twofold construction. Special leather belts, belt fastenings, splices in fabric belts, V-ropes, pulleys, and shaftings are considered as well as selection, installation, care, maintenance, and safety measures in the use of belts. British Standard Specifications, useful facts, technical data, and formulas are included.

VALVE GEAR DESIGN. By M. C. Turkish. Eaton Manufacturing Company, Wilcox-Rich Division, Detroit, Mich., 1946. Cloth 7 × 10¼ in., 130 pp., illus., diagrams, charts, tables, $6. While the general subject of valve-gear mechanisms is covered, emphasis is placed on the mathematical aspects of cam design and performance which occupy some three fourths of the book. Detailed examples and extensive tables add to its practical value in solving problems encountered in valve-gear design. The material presented is based on the author's considerable experience in both the production and research aspects of valve gear for all types of internal-combustion engines.

WIRELESS DIRECTION FINDING. By R. Keen. Fourth edition. "Wireless World," by Iliffe & Sons, Ltd., London, 1947. Cloth, 5 × 8 in., 1059 pp., illus., diagrams, charts, maps, tables, 45 s. Revised to include material on research work done during the war, this volume is intended for use as a manual, not a textbook. Navigation systems using the hyperbolic grid, the design and testing of high-frequency radiogoniometers, and transmission-line theory as applied to Adcock aerial systems are discussed. The cause and reduction of resonance effects in Adcock aerials and feeders, and H-F finding equipment are considered. A section on calibration has been added and that on beacons has been expanded. Radar is not included. A comprehensive bibliography of over 700 items covers the literature on directive reception and transmission as applied to navigation taken from 75 magazines within the period 1893–1947.

YEARBOOK OF THE HEATING AND VENTILATING INDUSTRY, published by Technitrade Journals, Ltd., London, England, 1947. Cloth, 5½ × 8¾ in., 139 pp., diagrams, charts, tables, 5s. Providing technical, contractual, and other trade information, this volume is of interest to architects, engineers, and others who have contact with heating and ventilating contractors. Technical articles in this edition are on thermal insulation, district heating, technical education, and standardization. Wage rates and apprenticeships are discussed from the British viewpoint. A list of corporation members, a buyers' guide, and a trade-name index are included.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer

and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 9, 1948, and approved by the Council on February 9, 1948.

CASE No. 1021 (Reopened)

(*Special Ruling*)

Inquiry: May plates, forgings and castings similar in chemistry to pipe in Specification SA-280 be used for Code construction? It is pointed out that ASTM Specifications A 301-47T covers such grade of plate of flange and firebox quality. Similar grades under Specification SA-217 for castings and Specification SA-182 for forgings are required for high temperature service. The application would be to Par. P-103 and to Table P-5. There would be no change in the allowable stresses as given in Tables P-5 and P-7 from those for carbon-molybdenum chromium.

Reply: Pending revision of existing specifications to include the chromium addition, it is the opinion of the Committee that the proposed chromium addition to carbon-molybdenum specifications will meet the intent of the Code. When welded, constructions built of these materials shall be thermally stress-relieved for all thicknesses.

CASE No. 1061

(*Special Ruling*)

Inquiry: Par. U-17(*a*) of the Code limits the minimum thickness of material to be used in welded construction to $^3/_{32}$ in. In consideration of the prevention of reduction in thickness in service, may fusion-welded vessels be constructed of stainless steel less than $^3/_{32}$ in. in thickness for non-corrosive service?

Reply: Welded vessels covered by Pars. U-69 and U-70 and made of corrosion-resistant steel conforming to Specification SA-240, Grades S, M, T, or C, as shown in Table U-2, may be constructed of thickness not less than $^1/_{16}$ in. provided all other requirements in the Code are met and the service for which the vessel is built in noncorrosive. Certain of these Code requirements are modified for these lighter gages, as shown in some of the following paragraphs.

The maximum allowable working stresses shall be those shown in Table U-2 for these grades.

The Procedure and Operator Qualifications shall be in accordance with Section IX of the Code except that:

(1) Procedure qualification shall include the making of two reduced-section transverse tensile specimens of the lightest gage used in construction, and in accordance with Fig. Q-6, and tested in accordance with Par. Q-108(a), and shall show the test results of Par. Q-109(a). Two specimens of this kind shall be made in each position used in actual fabrication.

When construction involves the use of fillet welds, test welds shall be made as required by Par. Q-105(b) in the thickness of material which will be used in actual construction. These welds shall be tested in accordance with Par. Q-108(d) and shall show the test results of Par. Q-109(d).

On these stainless steel specimens less than $^3/_{32}$ in. in thickness, the other procedure qualification tests shown in Table Q-1 may be omitted.

(2) The operator qualification tests shall be in accordance with Section IX, except that in Table Q-3 the making of one root-bend and one face-bend specimen on the thickness of material used in fabrication may be used; but in that case, the operator shall not be considered qualified for a thickness greater than twice that used in these tests.

If the thickness of the test specimen is other than $^3/_8$ in., the testing shall be done in a guided-bend test jig with the plunger and die member proportioned as follows:

Thickness of plunger member = 4 times the thickness of test specimen

Radius of plunger member = 2 times the thickness of test specimen

Width of opening, die member = 6 times the thickness of test specimen plus $^1/_8$ in.

Radius of die member = 3 times the thickness of test specimen plus $^1/_{16}$ in.

Specimens made in this operator qualification test shall be tested in accordance with Par. Q-208 and shall show the test results required by Par. Q-209.

Fillet weld specimens shall also be made as shown in Fig. Q-4, tested in accordance with Par. Q-108, and shall show the test results required by Par. Q-109.

CASE No. 1063

(*In the hands of the Committee*)

CASE No. 1064

(*In the hands of the Committee*)

CASE No. 1065

(*Special Ruling*)

Inquiry: Will it be permissible under the Code to build up fittings in accordance with the general fusion welding procedure of Par. U-68 except that the completed fitting shall be given a normalizing treatment in lieu of the stress-relieving requirement of Par. U-76.

Reply: It is the opinion of the Committee that the intent of the Code will be met if built-up fittings such as ells, tees, return bends, etc., are fabricated in accordance with the general procedure for fusion welding under Par. U-68 and other applicable paragraphs of the Code for the type of service intended, except that the completed fittings with flanges attached by welding may be given a full normalizing treatment for grain refinement in lieu of the 1100 to 1200 F stress-relieving. Testing shall be done after welding and after normalizing. The electrodes used for welding shall be selected with a sufficient high initial tensile strength to compensate for any loss in tensility of the seam due to normalizing.

Proposed Revsions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

Par. P-186(c). Add the following:

or a furnace may be attached by a full penetration weld, with the furnace extending at least through the full thickness of the tube sheet.

Par. P-199(c). Add the following:

Doubling plates may be applied by intermittent or continuous fillet welds with inner and outer plates held together by welded stays in accordance with the requirements for stayed surfaces. In such case the value of (C) shall be

150. The maximum pitch limitation of $8^1/_2$ in. in Par. P-204 shall not apply. Stress-relieving shall conform to requirements of Par. P-108.

Pars. P-239, P-242 (last section), P-243 (third section). Change references to "longitudinal joint" to read "longitudinal and circumferential joints."

Par. P-300. Insert the following as the fourth sentence of the fifth section:

For piping operating at temperatures above 800 F, the symbol may be stamped on a name plate which is irremovably attached by welding, provided such welding is stress-relieved, or on a circular metal band at least $^1/_4$ in. thick slipped over the end of the pipe.

Par. P-332(**c**). Add the following as the second section:

For equipment operating at temperatures above 800 F, the stamping may be applied to a name plate which is irremovably attached by welding to the part, provided such welding is stress-relieved.

Par. U-68(**e**) Revise second section to read:

The tensile strength of the joint specimen in Fig. U-15 when it breaks in the weld shall be not less than the minimum of the specified tensile range of the plate used. (The tension test of the joint specimen as specified herein is intended as a test of the welded joint and not of the plate.) If the specimen breaks in the plate at not less than 95 per cent of the minimum of the specified tensile range of the plate and the weld shows no sign of weakness, the test may be accepted as meeting the requirements. If the specimen breaks in the plate below this strength tolerance because of a local plate defect, one additional specimen shall be tested and shall meet the requirements.

Par. U-73 Revise as follows:

(c) Start this section to read:

(c) *Circumferential.* EXCEPT AS PROVIDED FOR INTERMEDIATE HEADS IN (**f**), circumferential and other joints of vessels, etc.

Add the following as (**f**), relettering present (f) as (**g**).

(f) Intermediate heads, without limit to thickness, of the type shown in Fig. U-18(**d**)* may be used for all types of vessels provided that the outside diameter of the head skirt (flange) is a close fit inside of the overlapping ends of the adjacent lengths of cylinder.

Par. U-77(**b**). Revise first sentence to read

Vessels built in accordance with the requirements of Pars. U-69 and U-70, 12 ft or less in diameter and/or 20 ft or less in vertical height, the welded joints of which are not stress-relieved and radiographed, shall be subjected to a hydrostatic test pressure of AT LEAST [not less than] $1^1/_2$ times BUT NOT MORE THAN 2 TIMES the maximum allowable working pressure, and while subject to this pressure all butt-welded joints that are not supported by other means, and all welded joints if such a test is feasible, shall be given a thorough hammer or impact test.

* Fig. U-18(**d**) will be Fig. 38 on page 25 of the interpretation pages.

Par. U-128. Replace last sentence by the following:

However, any gap in that portion of a stiffening ring supporting the shell as shown at *A* and *E* in Fig. U-28 shall not exceed the length of arc given in Fig. U-29 unless additional reinforcement is provided as shown at *H* in Fig. U-28, or unless:

(1) The length of unsupported shell arc does not exceed 90 deg;

(2) The unsupported shell arcs in adjacent stiffening rings are staggered 180 deg;

(3) The distance *L* used in the charts of Figs. U-22, U-24, and U-26 is taken as equal to twice the spacing between adjacent stiffening rings, or as the distance from the end of the cylindrical shell to the second stiffening ring; and

(4) All other applicable provisions of the Code, including the strength of the stiffening ring, are met.

Form U-1. A "Certificate of Field Assembly Inspection" will be added similar to that appearing in Form P-2, with editorial changes.

Table UA-8(**a**). Revise as follows:

Table UA-8(**b**) will be revised as it appeared in April, 1947, MECHANICAL ENGINEERING.

Par. U-201. Revise second section to read:

The hammer test as specified in Par. U-77(**b**) shall be made under a hydrostatic pressure of not less than $1^1/_4$ times but not more than 1.62 times the maximum allowable working pressure, EXCEPT THAT VESSELS 24 IN. OR LESS IN DIAMETER MAY BE TESTED TO 2 TIMES THE MAXIMUM ALLOWABLE WORKING PRESSURE.

New Material Specifications. The Committee has approved the adoption of the following ASTM specifications to be included in Section II of the ASME Boiler Construction Code:

A 299-47T Specifications for High Tensile Strength Carbon-Manganese-Silicon Steel Plates for Boilers and Other Pressure Vessels

A 300-47T Specifications for Steel Plates for Pressure Vessels for Service at Low Temperatures

A 301-47T Specifications for Chromium-Molybdenum Steel Plates for Boilers and Other Pressure Vessels

A 302-47T Specifications for Manganese-Molybdenum Steel Plates for Boilers and Other Pressure Vessels

TABLE UA-8 (a) GASKET MATERIALS AND CONTACT FACINGS

GASKET FACTORS (m) FOR OPERATING CONDITIONS AND MINIMUM DESIGN STRESS (y).
(Note: This Table gives a list of many commonly used gasket materials and contact facings with suggested design values of m and y that have generally proved satisfactory in actual service when using effective gasket settings width b given in Table UA-8 (b). These design values are suggested only and are not mandatory.

REFER TO TABLE UA-8 (b)

GASKET MATERIAL		GASKET FACTOR m	MIN. DESIGN SEATING STRESS y	SKETCHES AND NOTES	FACING LIMITATIONS	USE COL.
Rubber without fabric or a high percentage of asbestos fibre	Below 75 Shore Durometer	.50	0		USE ①④⑥ ONLY	
	75 or higher Shore Durometer	1.00	200			
Asbestos with a suitable binder for the operating conditions	1/8 Thick	2.00	1600			
	1/16 Thick	2.75	3700			
	1/32 Thick	3.50	6500			
Cloth inserted soft rubber		.75	50		NONE	
Cloth inserted hard rubber		1.25	400			
Rubber with asbestos fabric insertion, with or without wire reinforcement.	3 - ply	2.25	2200			
	2 - ply	2.50	2900			
	1 - ply	2.75	3700			
Vegetable fiber		1.75	1100		①④⑤	
Spiral-Wound Metal, Asbestos Filled	Carbon	2.50	2900		USE ①a ONLY	II
	Stainless	3.00	4500			
Serrated Steel	Asbestos Filled	2.75	3700			
Corrugated Metal Asbestos Inserted or Corrugated Metal, Jacketed Asbestos Filled	Soft Aluminum	2.50	2900			
	Soft Copper or Brass	2.75	3700			
	Iron or Soft Steel	3.00	4500			
	Monel or 4-6% Chrome	3.25	5500			
	Stainless Steels	3.50	6500			
Corrugated Metal	Soft Aluminum	2.75	3700			
	Soft Copper or Brass	3.00	4500			
	Iron or Soft Steel	3.25	5500			
	Monel or 4-6% Chrome	3.50	6500			
	Stainless Steels	3.75	7600			
Flat Metal Jacketed Asbestos Filled	Soft Aluminum	3.25	5500			
	Soft Copper or Brass	3.50	6500			
	Iron or Soft Steel	3.75	7600			
	Monel	3.5	8000			
	4-6% Chrome	3.75	9000			
	Stainless Steel	3.75	9000			
Grooved Iron or Soft Steel with or without Metal Jacketed	Soft Aluminum	3.25	5500		USE ①②③ ONLY	
	Soft Copper or Brass	3.50	6500			
	Iron or Soft Steel	3.75	7600			
	Monel or 4-6% Chrome	4.00	8800			
	Stainless Steels	4.25	10100			
Solid Flat Metal	Soft Aluminum	4.00	8800		NONE	I
	Soft Copper or Brass	4.75	13000			
	Iron or Soft Steel	5.50	18000			
	Monel or 4-6% Chrome	6.00	21800			
	Stainless Steels	6.50	26000			
Ring Joint	Iron or Soft Steel	5.50	18000		USE ⑧ ONLY	
	Monel or 4-6% Chrome	6.00	21800			
	Stainless Steel	6.50	26000			

ASME NEWS

And Notes on Other Engineering Societies

Compiled and Edited by A. F. Bochenek

Engineers Joint Council Offers Services to UNESCO

THE desire of American engineers to promote international understanding by co-operating with UNESCO (United Nations Educational, Scientific, and Cultural Organization) was expressed in a letter addressed to Milton S. Eisenhower, chairman, U. S. National Commission for UNESCO on Jan. 20, 1948, by R. M. Gates, past-president and Fellow ASME, and representative of the Engineers Joint Council on the National Commission. The letter follows:

Dear Dr. Eisenhower:

During the recent meeting in Mexico City, Dr. Arthur H. Compton suggested I write to you about the organization we have set up in the engineering societies to co-operate with your U. S. National Commission for UNESCO.

The Engineers Joint Council has authorized the appointment of a committee of counselors to advise me in my capacity as Council's representative on your Commission. The appointed counselors are: Harold C. Dean, New York, N. Y., Ralph L. Goetzenberger, Washington, D. C., George C. Heikes, New York, N. Y., Augustus B. Kinzel, New York, N. Y., Albert B. Newman, New York, N. Y., Stewart E. Reimel, New York, N. Y., Clifford S. Strike, New York, N. Y., Richard H. Tatlow 3rd, New York, N. Y., and Robert M. Gates, chairman, New York, N. Y.

(A short biography of each of these men was attached.)

At the dinner given by Dr. Needham at the Montejo Hotel in Mexico City, I outlined certain activities in which we are now engaged and other projects, compatible with the activities of UNESCO, under consideration.

For a number of years the engineers of America have been developing an extensive international relationship. This relationship has grown because of the demand for our engineering techniques by the peoples of the world. This development of engineering service has been essential therefore not only to the economic development of the States but to all countries.

The development of the applied sciences as wrought by the engineers has had a tremendous impact upon the social and political development of all nations. Realizing the importance of our work in modern civilization, we have long awaited the opportunity for further co-operation and mutual assistance that UNESCO now makes possible.

We have approximately 100,000 members in the constituent Societies represented by the Engineers Joint Council. These engineering Societies are selective in their membership. In order to become a member of these selective groups, one must not only be interested in the progress of his profession, but must have several members sponsor his application. Thereafter, the prospective member is investigated for education, experience, and moral character. Hence we have in these Societies a well-qualified and selected group of engineers who are the leaders in the profession. They are the executives of the large mining, construction, chemical, and manufacturing companies, educators, and research men who are accustomed to putting ideas into action.

Seven thousand of these active practicing engineers, speaking the universal language of technology, and in most cases the native tongues in the 80 countries where they are working, are thoroughly acquainted with these foreign engineers and their problems. These men represent the American point of view, wherever they are. They are co-operating with engineers of other nations in the modern techniques and practices of civil, mining, mechanical, electrical, and chemical engineering. These members contribute to the proceedings in their own Societies and to the technical literature which is accessible to all who are interested.

These Societies have nearly 400 committees, on which almost 5000 engineers are active. One hundred seventy-two of these committees are co-operating with allied engineering groups. There are 334 local forums and 513 student chapters in universities. Regularly scheduled meetings both in the United States and in foreign countries keep this large group in constant touch with contemporary issues.

Since the war, over 70,000 volumes of technical literature have been donated to libraries and colleges in the devastated areas. This activity is to be augmented. The Societies have 91 centers in foreign countries for the free distribution of their published periodicals and literature. The Engineering Societies Library buys and distributes to 211 additional book centers. These are largely public or university libraries. In 1947 we had 7000 subscriptions to our engineering periodicals from foreign countries. These were purchased by individuals, industries, and government agencies, not members of the Societies.

Many of the members of our Societies are also members of foreign engineering groups and many of these members regularly attend their meeting in the various foreign countries. Under the direction of these Societies, we have given fully paid scholarships to foreign students to attend our universities. Individuals, as well as committees, of the Societies are participating in many activities throughout the world in technological developments of mutual interest. These apply to standards, safety, properties of gases and materials, gages, measures, processes, alloys, and countless other subjects too extensive to outline here.

We have faith in the opportunities for UNESCO. We desire to synchronize our activities with the work of your committees. We have outlined a brief summary of our activities and facilities to give you an idea of our potential value to your Commission. May I say again that we wholeheartedly pledge our support. We will be receptive to any suggestions you have to make as to how we can better co-operate with you.

I await your pleasure should you desire to discuss this subject with us.

Respectfully yours,

R. M. Gates

Note for ASME Travelers

Are You Available as an ASME Speaker?

ENGINEERS who are planning to make business trips to the South, Southwest, or the West in the next three or four months are cordially invited to speak before ASME Sections in cities they plan to visit.

Local engineers are often disappointed because they miss an opportunity to hear prominent members of the profession who are visiting among them. Last-minute invitations are usually declined with regret because of the speaker's long-standing business commitments.

If you are available as a speaker and are planning an extended business trip in the late spring or early fall, please notify ASME Headquarters. Give us your itinerary, the topic on which you are prepared to speak, and information on fees and other charges.

This information will be wired to ASME Sections along your proposed route for use in program making.

Annual-Meeting Publicity Sets New High Mark

THE ASME 1947 Annual Meeting was the best publicized Society meeting in years, according to George A. Hastings, ASME director of public relations. Based on clippings received from one clipping bureau by mid-January, newspapers in 42 states and the District of Columbia published stories of the meeting. Many of these were front-page stories and twelve were editorials.

In all, 600 clippings equivalent to 208 columns of space, representing more than three times the publicity received for the 1946 Annual Meeting, were received. New York newspapers carried 75 stories, newspapers elsewhere 445, and periodicals 68.

Tuesday, Dec. 2, 1947, and the following morning newspapers throughout the nation carried the ASME on the front pages with stories featuring the address of David Lilienthal. In the New York area alone the story won front-page billing in the New York *Times*, *Herald Tribune*, *World Telegram*, *Sun*, *Journal-American*, and *Newark Evening News*.

Excellence of the program, popular nature of many of the papers, "big-name" speakers, advance publicity, and good public relations were the reasons attributed for the wider recognition accorded the ASME by the daily newspapers.

In the preparation of the advance publicity, 106 of the 216 papers and addresses were checked for promising publicity material. Some 40 papers were selected and served as the basis of 31 news releases which were distributed nationally. These releases, it was noted, formed the basis of most of the clippings received.

To help reporters, editors, and special writers obtain material for stories, the Society operated a pressroom in Atlantic City. This was fully staffed and was open 12 hours a day. This service was appreciated by newswriters, many of whom wrote letters commenting favorably on the assistance received during the meeting.

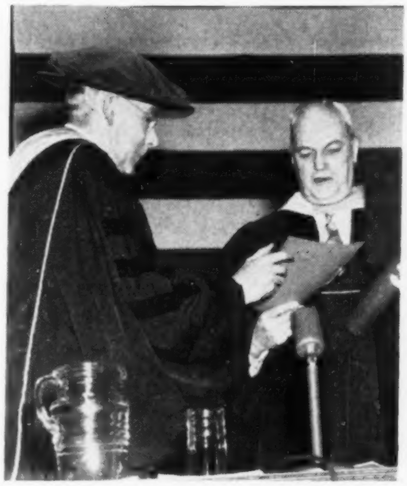
Joseph Slepian Receives AIEE Award

THE Edison Medal for 1947 for meritorious achievement in electrical science has been awarded to Joseph Slepian, associate director of the Westinghouse Research Laboratories, "for his practical and theoretical contributions to power systems through circuit analysis, arc control, and current interruption," it was announced recently by the American Institute of Electrical Engineers, sponsors of the award.

Dr. Slepian developed the ignitron, an electronic tube now widely used in the production of aluminum and magnesium, and did outstanding pioneer work in the design of circuit breakers and lightning arresters for the protection of power systems.

The medal was scheduled for presentation on Jan. 28, 1948, during the winter convention of the American Institute of Electrical Engineers in Pittsburgh, Pa.

Three ASME Members Honored by Stevens Institute



GEORGE A. STETSON (RIGHT) RECEIVES HONORARY DEGREE OF DOCTOR OF ENGINEERING FROM HARVEY N. DAVIS, PRESIDENT OF STEVENS INSTITUTE OF TECHNOLOGY HOBOKEN, N. J.

GEORGE A. STETSON, member ASME and editor of MECHANICAL ENGINEERING, received an honorary degree of doctor of engineering from the Stevens Institute of Technology, Hoboken, N. J., after which he delivered the commencement address at ceremonies held in the administration building of the Institute, Jan. 31, 1948. The same honorary degree was conferred on Allan R. Cullimore, member ASME and president of the Newark College of Engineering, Newark, N. J.

At a dinner given by the Alumni Association of the Institute in the Astor Hotel, New York, N. Y., Jan. 30, 1948, Harvey N. Davis, Fellow and past-president ASME, was honored on his 20th anniversary as president of Stevens Institute. Dr. Davis received the honorary degree of doctor of engineering from Stevens and a special 20th-anniversary silver medallion from the Alumni Association as well as the Stevens Honor Award presented annually for "notable achievement."

In the citation, Dr. Davis hailed Dr. Stetson as the "effective 'voice of America' speaking to fellow engineers in many lands" and "as one whose broad and deep understanding of the part that engineers are playing in the modern world is a constant inspiration to them to do still more for the common good." Referring to Dr. Stetson's 15 years of university teaching, the citation went on to say that he was "now rounding out twenty years of teaching of another sort as editor of the publications of The American Society of Mechanical Engineers, which, under his direction have won acclaim as being among the very best technical periodicals in the world."

In his address, Dr. Stetson told the young men that the engineer must supplement his technical knowledge of science and engineering with a knowledge of men and organizations to meet the critical production needs of the world today.

"Machinery and methods," he said, "respond to the rational treatment of science and engineering. They adhere strictly to the laws of their natures and these laws are fairly simple and well known. But machinery and methods are useless without men, and men respond to laws that are complex and obscure. When the engineer is forced to take over not only the job of developing, maintaining, and operating the machinery of production but the handling of men as well, he finds that his knowledge of science and engineering must be supplemented with a knowledge of men and organizations. Just as he must devise useful mechanisms and products from the discoveries of science, so also must he devise smoothly operating and effective organizations of men for producing them."

Dr. Cullimore is a past vice-president of the American Society for Engineering Education and has been a leader in setting the standards for student selection and guidance through his work with the Engineers' Council for Professional Development. As a member of national committees on national defense, postwar planning, and labor legislation, he has presented the engineer's point of view on many civic projects.

Midwest Power Conference to Be Held April 7–9

THE 1948 Midwest Power Conference will be held at the Sheraton Hotel, Chicago, Ill., April 7–9, 1948, according to Stanton E. Winston, member ASME, director of the conference.

As its part in the conference the ASME Chicago Section is sponsoring a joint luncheon on Wednesday, April 7, at which Robert Krause, chairman of the Chicago Section, will preside. This will be followed by a technical section on central-station practice sponsored by the Power and Fuels Division of the Chicago Section. Speakers have not been announced.

Excellent Attendance at 1947 Annual Meeting Technical Sessions

TWENTY-FIVE of the 55 technical sessions at the ASME 1947 Annual Meeting in Atlantic City, N. J., attracted larger audiences than comparable sessions during the 1946 meeting in New York, N. Y., according to a recent study of costs and attendance data compiled for the Meetings Committee.

The unfavorable aspect of the Atlantic City meeting was the 200 per cent increase in administrative cost caused by the expenses of headquarters staff, increased gratuities, use of

better public-address systems, and expenses of student aides coming from New York and Philadelphia.

The 1947 figures for attendance at technical sessions was considered remarkable because of the 40 per cent reduction in registration caused by moving the meeting away from New York, N. Y.

While due in part to the excellence of the program, the Meetings Committee feels that conditions favorable to the ASME type of meeting found in Atlantic City were an important factor in the success of the technical program. For one thing, adequate facilities made it possible for 46 per cent of the registrants to stay at the headquarters hotels. The comparative figure for New York was 10 per cent. In Atlantic City, 40 nearby hotels and clubs housed the remainder of the registrants, while in New York the preceding year, 50 different hotels all over the city were used. Because so many members stayed near the headquarters hotels, it was convenient to remain longer on the scene of the meeting and to participate more fully in the program.

The item of cost to members, which caused the Committee some concern in breaking the New York annual meeting precedent, also takes on a more favorable aspect in the light of experiences in Atlantic City. Except for the main hotels, rooms near headquarters were lower in cost than those in New York. Good restaurants, convenient to the meeting, serving meals at New York prices, also helped to reduce costs for many members.

Of the total registration of 3216, more than one half were members and the others guests, students, and women. The largest single delegation came from Pennsylvania, the metropolitan New York area was second, New Jersey third, New York State fourth, and Illinois fifth.

The largest reduction in registration in comparison with 1946 attendance was in the metropolitan New York area and Connecticut groups with a reduction of 67 and 72 per cent, respectively. The New Jersey group showed a reduction of 48 per cent.

Hydraulic Division Organizes New Committee

THE Hydraulic Division of The American Society of Mechanical Engineers organized a new committee at the 1947 Annual Meeting to provide closer co-operation in the field of positive-displacement hydraulic mechanisms between engineering and research personnel.

The principal objectives of the new committee are: (1) To encourage publication of engineering and research papers; (2) to participate in setting up standards for industry; (3) to encourage research and educational programs; and (4) to co-operate with other organizations active in fields of interest to the Committee.

As its first effort, the Committee is planning to present two papers at the 1948 Semi-Annual Meeting in Milwaukee, Wis., this summer.

W. E. Wilson, director of research, Sundstrand Machine Tool Company, Rockford, Ill., is chairman. Other members of the Committee are: Hans Ernst, research director, Cincinnati Milling Machine Company, Cincinnati, Ohio; S. R. Beitler, professor of hydraulic engineering, Ohio State University, Columbus, Ohio; R. H. Davies, engineering manager, Parker Appliance Company, Cleveland, Ohio; O. E. Teichman, research engineer, Armour Research Foundation, Chicago, Ill.; A. B. Riddiford, hydraulic engineer, J. S. Barnes Corporation, Rockford, Ill.; C. T. Link, hydraulic division, Racine Tool and Machine Company, Racine, Wis.; R. C. Binder, Purdue University, Lafayette, Ind., and E. F. Wright, chief engineer, reciprocating pump division, Worthington Pump and Machinery Corporation, Harrison, N. J.

Members interested in positive-displacement hydraulic mechanisms who wish to contribute to the committee's program are invited to communicate with the chairman.

New Dutch Publication Announced

A NEW Dutch publication project called *Applied Scientific Research* and sponsored by three Dutch research agencies was announced recently by Martinus Nijhoff, publisher of The Hague, Netherlands.

The project calls for publication in English of two volumes of original research in the field of applied science over a period of 18 months. One volume will contain papers on mechanics and heat, and the other on electrophysics, accoustics, and optics. An editorial board of Dutch scientists will pass on papers selected for publication. Subscription rate is 20 guilders or about $8 for each volume.

ASME Publishes New Safety Code for Conveyers

THE American Society of Mechanical Engineers recently published a new safety code for mechanical conveyers to serve industry in its fight against accidents resulting from use of conveying equipment. The new code called "Safety Code for Conveyers, Cableways, and Related Equipment, ASA B20.1-1947," was written jointly by the ASME and the National Conservation Bureau under the procedures of the American Standards Association.

Its purpose is to serve as a guide for state authorities in drafting state safety codes and regulations. Its voluntary use by manufacturers and users of mechanical conveyers will provide a safety standard to be followed by operators and supervisors.

The code covers safety suggestions for construction, installation, operation, and maintenance of conveyers and conveying machinery such as power conveyers, gravity conveyers, pneumatic tubes, tiering conveyers, and cableways, but does not treat self-propelled steerable industrial trucks.

Part I covers general safety regulations for conveying equipment; Part II deals with specific regulations applying to the various classes of equipment such as serial cableways, apron, belt-bucket, chain, and other types of conveyers.

The provisions of the code are the consensus of a working committee of more than 50 representatives of manufacturers, users, insurance companies, government agencies, and specialists in the field of conveyer equipment. D. L. Royer, member ASME, Ocean Accident and Guarantee Corporation, New York, N. Y., was chairman.

Copies may be obtained from Publications Sales, ASME, 29 West 39th Street, New York 18, N. Y., at 90 cents per copy.

Applied Mechanics Reviews Published by ASME

THE first issue of *Applied Mechanics Reviews*, a new monthly review journal published by The American Society of Mechanical Engineers in co-operation with 10 other engineering and scientific societies, was released in January, 1948.

The new publication presents a critical review of world literature in applied mechanics. It aims to help workers in mechanics throughout the world to keep informed about the work being done elsewhere in this field. More as a guide to reading rather than a source of detailed information, *Applied Mechanics Reviews* makes available a review of papers published in more than 500 scientific journals throughout the world.

In a format similar to that of other ASME publications, such as the Transactions and the *Journal of Applied Mechanics*, the first issue of the new publication contained 32 pages with more than 200 reviews of approximately 200 words each, grouped under 32 different headings, such as, wave motion, impact, seismology; buckling problems; material test techniques; aerodynamics of flight, wind resistance; heat transfer; and others.

Among the co-operating societies are: The Institution of Mechanical Engineers, The Engineering Institute of Canada, Engineering Foundation, and others. L. H. Donnell, member ASME, is editor.

Annual nonmember subscription is $12.50; single copies sell for $1.50. To members of the ASME and co-operating societies, subscription is $9 per year; single copies $0.75. Copies may be obtained from ASME Publication Sales Department, 29 West 39th Street, New York 18, N. Y.

Danish Engineers Dedicate New Building

THE Danish Engineering Society dedicated its new engineering building in Copenhagen, Denmark, Jan. 21, 1948. The old building, which stood close by the one used by the German gestapo, was destroyed during an air raid in 1945. As part of the ceremonies a memorial plate was unveiled honoring civil engineers who gave their lives for the freedom of Denmark. A. K. Bak, member ASME, Municipal Electricity Works, Copenhagen, Denmark, represented the Society at the ceremonies.

WSE Plans Women's Division

OFFICIALS of The Western Society of Engineers met recently with a group of licensed professional women architects and engineers in the Chicago area to formulate plans for a Women's Division of the society.

Objectives of the new division will be to give the professional women in the engineering field an opportunity for individual and professional advancement through self-expression and contributions to civic developments of an engineering nature.

Mining Engineer Wins 1947 Alfred Noble Prize

JOHN H. HOLLOMON, junior member AIME, research associate, General Electric Company, Schenectady, N. Y., has been awarded the Alfred Noble Prize for his paper, "The Mechanical Equation of State," which was published in *Metals Technology* of the American Institute of Mining and Metallurgical Engineers. The prize was presented at the annual meeting of the Institute held in New York, N. Y., Feb. 18, 1947.

Mr. Hollomon is a graduate of the Massachusetts Institute of Technology. At present he is directing research in physical metallurgy for the General Electric Company. He is the author of numerous papers on metallurgy and physics, and co-author of a recently published book entitled "Ferrous Metallurgical Design."

The Alfred Noble Prize was established in 1929, made possible by Mr. Noble, past-president ASCE, and is awarded annually to a young member of one of the four Founder Societies or the Western Society of Engineers for a published technical paper of unusual merit.

R. J. S. Pigott New SAE President

R. J. S. PIGOTT, Fellow ASME, and chief engineer, Gulf Research and Development Company, Pittsburgh, Pa., was elected as president of the Society of Automotive Engineers for 1948. He assumed office following the close of the SAE annual meeting in Book-Cadillac Hotel, Detroit, Mich., Jan. 13, 1948.

D. S. JACOBUS (LEFT) ACCEPTS THE NEW PAST-PRESIDENT'S EMBLEM FROM PRESIDENT E. G. BAILEY

(The ceremony took place at the regular January meeting of the ASME Boiler Code Committee on which Dr. Jacobus serves as honorary chairman. Dr. Jacobus, who is an honorary member, served the ASME as manager from 1900 to 1903 and president in 1916. He has been a member of the Boiler Code Committee since its organization in 1911.

Dr. Jacobus received a regular ASME emblem for the fellow grade set with a six-point diamond and inscribed on its reverse side to note his year of service as president. Similar emblems are to be presented in the future to each ASME president as he leaves office.)

British Publish New Science Journal

THE Engineering Societies Library recently received copies of the first three issues of a new monthly British journal of science and its application called *Research*, and published by the Butterworths Scientific Publications, Ltd., London.

Organized by British scientists headed by Sir John Anderson, the journal aims to fill the gap left by the disappearance from the international markets of the German scientific publications. The journal will not specialize in any field but will try to reduce the time interval between initial research and the practical development based on it by presenting new discoveries, new applications, and new techniques in nonspecialized language to appeal equally to the trained scientist and to the industrialist. Annual subscription is $10.

ASME Materials-Handling Conference a Success

A ONE-DAY conference on materials-handling problems was sponsored by the Materials Handling and Management Divisions of the Society in co-operation with the ASME Cleveland Section as part of the Second National Materials-Handling Exposition, held in Cleveland, Ohio, Jan. 12 to 16, 1948.

The ASME program consisted of two technical sessions and a dinner held at the Hotel Statler, Tuesday, Jan. 13. Four papers were presented covering such subjects as progress in materials handling at the International Harvester Company, and the relations of materials handling to man-hour reduction and product diversification.

A feature of the conference was a dramatization of materials-handling equipment in action, a one and one-half hour pageant which depicted receiving-department activities, warehousing, and unit loads in transit.

Engineering Salaries Paid by Cities Reported in Recent Survey

WESTERN cities pay chief city engineers most and cities in the northwestern section of the United States pay least, according to a recent survey conducted by the American Association of Engineers, Chicago, Ill.

This fact and many others are published in a 24-page booklet "Incomes of Professional Engineers in Public Employment," which summarizes data obtained from 180 typical cities located in 42 states regarding salaries paid in 9 engineering positions in 1938, 1942, and 1947.

The booklet is intended as an aid to engineers and employers in determining equitable compensation for engineering services.

The survey reports that average salaries of 50 per cent of municipal engineers increased from $2680 in 1938 to $3670 in 1947 and that the salaries of chief engineers increased from $3640 in 1938 to $4950 in 1947.

The booklet may be obained for $1 from the American Association of Engineers, 8 South Michigan Avenue, Chicago 3, Ill.

1948 Regional Administrative Committee Meetings

Region	*City*	*Hotel*	*Date*
I	New London, Conn.	Mohican	March 25–26
II	New York, N. Y.	Headquarters	April 7–8
III	Elizabeth, N. J.	Winfield Scott	March 23–24
IV	Savannah, Ga.	De Soto	April 4–5
V	Pittsburgh, Pa.	Roosevelt	April 14–15
VI	Louisville, Ky.	Kentucky	April 23–24
VII	Spokane, Wash.	Davenport	April 30–May 1
VIII	Kansas City, Mo.	President	April 17–18

ASME Headquarters News Notes

READER Survey of MECHANICAL ENGINEERING has been resumed with the January, 1948, issue. The Publications Committee wants constructive criticism on the "Junior Forum" and the "ASME Technical Digest."

Space devoted to news about Section and Student Branch activities is being reduced this month because of lack of interest in these departments indicated by reader surveys.

Because of the diversity of ASME activities, approximately 650 pages of instruction manuals on Committee and Society operation have accumulated over the years. An effort is being made to consolidate this information in one or more pamphlets. When completed, availability of the manuals will be announced.

The revival of interest among Junior members for service as advisers on ASME administrative committees has resulted in a project to review current Society policy on junior advisers.

ASME Calendar

of Coming Events

March 1–4, 1948
ASME Spring Meeting
New Orleans, La.

May 20–22, 1948
ASME Oil and Gas Power Division Meeting
St. Louis, Mo.

May 30–June 5, 1948
ASME Semi-Annual Meeting
Milwaukee, Wis.

June 17–19, 1948
ASME Applied Mechanics Division Meeting
Chicago, Ill.

Sept. 13–17, 1948
ASME Instruments and Regulators Division Meeting
Philadelphia, Pa.

Sept. 20–21, 1948
ASME Aviation Division Meeting
Dayton, Ohio.

Oct. 3–6, 1948
Petroleum Committee of the ASME Process Industries Division Meeting
Amarillo, Texas.

Nov. 3–4, 1948
ASME Fuels Division Meeting
White Sulphur Springs, W. Va.

Nov. 28–Dec. 3, 1948
ASME Annual Meeting
New York, N. Y.

Jan. 10–14, 1949
Materials Handling Division and Management Division Meeting
Philadelphia, Pa.

To improve service to members, the whole professional-division organizational structure is being studied by the Professional Divisions Committee.

Sponsors of the third National Materials-Handling Exposition recently invited the ASME to take full responsibility for arranging an entire 5-day technical program for the exposition.

The five-dollar nonmember registration fee for national ASME meetings will be continued according to a decision of the Professional Divisions Committee to see how the policy affects membership development.

The Engineers Joint Council has authorized its Commission on Latin America to proceed with its plan for establishing the *Adelantos de Ingenieria* on a permanent self-supporting basis. An attempt will be made to encourage advertisers to provide funds. *Adelantos* is a quarterly journal which reprints selected articles from Founder Societies' publications for benefit of Latin-American engineers.

Six professional Divisions have scheduled national conferences between Sept. 13 and Nov. 3, 1948. Watch for programs.

First issue of *Applied Mechanics Reviews* with 32 pages and more than 200 reviews was published in January, 1948.

A "Safety Code for Conveyers, Cableways, and Related Equipment" and Oil and Gas Power Division's lectures on "Diesel Fuel Oils" are among recent ASME publications.

"The Engineering Societies Yearbook" published last month by the ASME, makes available for the first time a convenient source of information on joint engineering bodies and 300 national, state, regional and local clubs and councils. Thirty-five Canadian organizations are also covered. Cost is $3 per copy.

1948 Edition of "Who's Who in Engineering" Now Available

THE sixth edition of "Who's Who in Engineering" was released in February, 1948, and is now in the course of distribution. Qualifications of engineers included in the volume were established by an advisory committee set up by the Engineers Joint Council under the chairmanship of A. A. Potter, Fellow and past-president ASME, dean, school of engineering, Purdue University.

The qualifications for inclusion are:

(1) Engineers of outstanding and acknowledged eminence.

(2) Engineers of at least 10 years' active practice, at least five years of which have been in responsible charge of important engineering work.

(3) Teachers of engineering subjects in colleges or schools of accepted standing who have taught such subjects for at least 10 years at least five of which have been in responsible charge of a major engineering course.

The volume is 12 per cent greater in coverage than the 5th edition with approximately 16,000 engineers presented. The volume sells for $15 and may be obtained from the Lewis Historical Publishing Company, Inc., New York 11, N. Y.

Employers Co-Operate in National-Defense Training

MANY employers throughout the nation are granting special leaves of absence to employees enrolled in military reserves to permit them to take annual military training without loss of vacations or pay, according to a recent survey made by the Chamber of Commerce of the United States.

Out of the 1256 reporting companies, 720 have adopted reserve-leave policies and 132 more plan to do so, according to the survey report. The majority of the companies grant two weeks or 15 days' training leave in addition to the employees' regular vacations.

The results are summarized in a pamphlet entitled, "Company Leave Policies for Employees in Reserves of the Armed Forces Including the National Guard," which outlines company reserve-leaves practices in a wide variety of companies including those in manufacturing, finance, utilities, and distribution.

The survey report points out the importance of the civilian Reserves of the Armed Forces and the National Guard as an integral element of an adequate program of national security, and commends the many employers who are granting special leave of absence to their employees who are members of the military reserves in order to enable them to maintain their reserve status.

There were 1256 employers who participated in the survey and supplied information relative to any reserve-leave policies which had been adopted, the length of training leave granted, the effect of such leave on the employees' regular vacations, compensation during the leave period, and similar matters.

"Universities" Sponsored by ECPD

THE first series of "universities" for graduate engineers staffed by practicing members of the profession is in operation in Detroit. Sponsored by the Engineers' Council for Professional Development and announced during the 1947 Annual Meeting of The American Society of Mechanical Engineers, this "university" and others in key cities will give courses, lectures, and consultations to engineering graduates.

In the Detroit experiment, the ECPD, working with the local engineering society and its affiliates, arranged the courses and lectures. The faculty is made up of engineers in active duty in the area, and the "regents" are the past-presidents of the society.

AAAS Elects Officers

AT a recent meeting of the Association for the Advancement of Science in Chicago, Ill., E. C. Stakman of the University of Minnesota, St. Paul, Minn., was named president-elect. William R. Osgood, U. S. Navy, David Taylor Model Basin, Washington, D. C., was elected vice-president for Section M (Engineering).

Symposium Planned by U. of Wisconsin Sept. 7–11

THE Third Symposium on Combustion and Flame and Explosion Phenomena, sponsored by the University of Wisconsin, will be held at Madison, Wis. Sept. 7–11, 1948. The Symposium will be part of the Centennial celebrations of the University.

Formal papers to be presented will cover theoretical as well as applied aspects of the subject. Papers are expected on such subjects as, limits of inflammability, detonation, thermodynamics of flame reactions, radicals and atoms in flames, new experimental techniques, etc. Engineering aspects of the subject will center about technical research, combustion problems in jet propulsion, and economic and technical aspects of special fuels.

Round-table discussions are also planned on thermodynamics and the physical properties of hot gases, thermochemistry, turbulence and its effect on combustion, development of instruments and experimental techniques for combustion studies, and others.

Authors are requested to submit titles of papers and a 1000-word abstract not later than August 1, 1948, to Dr. Bernard Lewis, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pa.

Engineers planning to attend this symposium are requested to notify Dr. J. O. Hirschfelder, Department of Chemistry, University of Wisconsin, Madison, Wis.

H. S. Person Receives Management Award

HARLOW S. PERSON, member ASME, was awarded the gold medal of the International Committee of Scientific Management at a dinner sponsored in his honor by the National Management Council at Hotel Pennsylvania, New York, N. Y., February 7, 1948.

Dr. Person, who is a consultant in business economics and management, an internationally recognized pioneer in the field of scientific management, was cited for the medal at the 8th International Management Congress held in Stockholm, Sweden, July, 1947. where his paper "Progress in Scientific Management" was read.

Dr. Person's paper was published in the November, 1947, issue of MECHANICAL ENGINEERING.

Centennial Celebrations Planned by AAAS

THE American Association for the Advancement of Science recently appointed a centennial-policy committee to make general plans for the AAAS Centennial Celebration to be held in Washington, D. C., Sept. 13 to 17, 1948. The theme of the centenary will be "One World of Science." A number of symposiums are planned of interest not only to scientists and engineers but also to the general public.

Members at Large Sought by FAS

THE Federation of American Scientists, a group organized to alert the public to the implications of the development of atomic energy and to work for sound legislation and policy in this field, has recently announced provision for admission of members at large.

Those who have the equivalent of a bachelor degree in the natural sciences, mathematics, or engineering are qualified to become members at large and others interested in furthering the aids of the Federation are eligible for associate memberships at large.

Annual dues for members at large are $5, for sustaining members $10, and for patrons $25.

Among the major activities of the Federation have been providing accurate technical information to the public, mobilizing support for civilian control of atomic energy, and working for a National Science Foundation.

Other projects to be supported are the reestablishment of the international scientific community for interchange of scholars, students, and technical information, and the general problem of secrecy in science.

Additional information about the Federation may be obtained by writing to the Federation of American Scientists, 1749 L Street, N.W., Washington 6, D. C.

ASME Textile Division Holds Annual Meeting

THE Textile Division of The American Society of Mechanical Engineers held its annual meeting at the Copley Plaza Hotel, Boston, Mass., Jan. 8, 1948. Eighty-four members and guests were present.

The program consisted of two technical sessions at which seven papers were presented on such subjects as fire hazards in the textile industry, latest developments in textile dyeing machines, and developments in personal relations.

A feature of the meeting was a symposium on management and labor relations, at which N. M. Mitchell, president of Barnes Textiles Associates, Boston, Mass., was chairman.

During the morning session a motion picture presented by R. J. Dixson, Chicopee Mfg. Corp., New Brunswick, N. J., depicted work being done by his organization in the field of personnel relations.

ASME Diesel Fuel Oil Lectures Published

DURING the 19th National Oil and Gas Power Conference held in Cleveland, Ohio, May, 1947, the Oil and Gas Power Division of the ASME sponsored a course of lectures reviewing the knowledge and current techniques in the field of Diesel fuel oils. So enthusiastically were the lectures received that the speakers were encouraged to prepare their notes and slides for publication. The result is a handsome 128-page booklet just published by the ASME containing not only the lectures and illustrations but also the discussions stimulated by the lectures.

The new publication, "Diesel Fuel Oils—Production, Characteristics, and Combustion," describes the refining techniques now in use in this country, the chemistry and properties of the principal hydrocarbons of interest to the Diesel power field, and the theory and fundamental factors affecting the combustion of Diesel fuel oils.

Copies sell for $3.50 each and may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Meetings of Other Societies

March 15–19
American Society of Tool Engineers, annual meeting and industrial exposition. Hotels Carter, Cleveland, Statler, and Public Auditorium, Cleveland, Ohio

March 18–19
American Management Association, marketing meeting, Hotel New Yorker, New York, N. Y.

March 30–April 1
Society of Automotive Engineers, Inc., national transportation meeting, The Bellevue-Stratford, Philadelphia, Pa.

April 5–8
Third Southern Machinery and Metals Exposition, Municipal Auditorium, Atlanta, Ga.

April 7–9
Illinois Institute of Technology, 10th annual Midwest power conference, Sheraton Hotel, Chicago, Ill.

April 7–9
American Society of Civil Engineers, spring meeting, William Penn Hotel, Pittsburgh, Pa.

April 13–16
Greater New York Safety Council, Inc., 18th annual safety convention and exposition, Hotel Pennsylvania, New York, N. Y.

April 18–23
American Chemical Society, 113th national meeting, Chicago, Ill.

April 26–28
American Mining Congress, coal convention, Netherland Plaza, Cincinnati, Ohio

May 9–12
American Institute of Chemical Engineers, Cleveland meeting, Hollenden Hotel, Cleveland, Ohio

May 27–29
Society for Experimental Stress Analysis, annual meeting, The Roosevelt Hotel, Pittsburgh, Pa.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, C. H. CARMAN, JR., CHAIRMAN

Who Are "They"?

OFTEN we hear junior and other members as well complain that "they should hold more meetings," or "they should give me more for my dues," or "they should put more articles in MECHANICAL ENGINEERING." Just who is this mysterious group known as "they?"

The answer is that "they" refers to the plain ordinary members of the Society who are interested enough in it to spend time and energy serving it. "They" are regular people like you and me who have jobs, wives, families, and many other things to occupy their time but still manage to work for the Society. Many of our members put in many hours working for a profession and a large group of people whom they have never seen and will never meet. It is true that they realize certain compensations such as pride in knowing of a job well done and friends acquired in the doing. These rewards are really merited as they were worked for and earned.

There is no reason why any member should complain about what "they" do. If you feel for example that "they should hold more meetings," why not show them how you think it should be done. Volunteer to run a meeting, or arrange the program. If there is no active group near you, organize a few engineers in your vicinity and hold a little get-together. If there is an active group and they have a fairly full program, bide your time and you will be given your chance.

Yes, it is very easy to lean back and say that "they should do this and they should do that," but when you do stop to consider who "they" are, and when you reflect that it is just a group of members trying to do their best for you, think again and then give "they" a hand to see if your ideas can be put to good advantage.

C. H. C.

Junior Committee Meets

THE ASME Junior Committee was honored at its meeting on Jan. 17, 1948, by the presence of Pres. E. G. Bailey. President Bailey commented favorably on the work that had been done but pointed out that the committee still had a long way to go.

The results of the pamphlet, "It's Up to You," were surveyed. While the reaction to this booklet has been good, the number of inquiring letters has not been as voluminous as expected.

A letter was drawn up for mailing to all ASME section chairmen calling attention to the junior program, inviting suggestions, asking for the names of several capable junior members with whom the committee could correspond, and enclosing a copy of the pamphlet.

Several sections which do not now have junior groups were discussed as potential locations. It was suggested that a member of the committee attend the first meeting of any such new groups that were started. Because of the travel expense involved and other considerations, however, it was decided that the regional vice-presidents could best handle this function.

The "Junior Forum" and the difficulties of securing material for it were considered. C. H. Carman reported that his editorial committee has been expanded but that he was still looking for men in other parts of the country who would be willing to contribute to this undertaking. D. E. Jahncke, chairman of the Junior Committee, promised additional book reviews and at least two articles from the Detroit Section. Summaries of interesting articles which have already appeared in MECHANICAL ENGINEERING, but which may have been missed, were also suggested.

No action was taken on the Engineer's Canon of Ethics. The Metropolitan Junior Group has not yet made its recommendations.

C. E. Davies, secretary ASME, told the committee that the Society was anxious to continue to expand the practice of having junior advisers on each committee. At present only five standing committees have junior advisers and the Organization Committee has requested the Junior Committee to study and make recommendations on the method and selection of junior members for these positions.

If you have any suggestions on this problem or would like to volunteer your services, write to Philip Allen, Stonehurst Court Apartments, Upper Darby, Pa. Suggestions will be more than welcome.

D. E. J.

Black Liquor

THE "Junior Forum" from time to time will endeavor to cast its spotlight on junior members who are doing outstanding work in the engineering profession. Many juniors have contributed excellent papers for the Society's technical sessions.

One of the papers presented at the ASME Spring Meeting in New Orleans, La., was by a junior member, R. K. Allen. Mr. Allen's paper was on "Developments in Kraft-Process Recovery-Unit Design and Performance." This paper concerns itself with the art of burning "black liquor."

This black liquor is obtained from the digesters in which wood is "cooked" under pressure with steam, using a solution of sodium hydroxide and sodium sulphide. In the cooking process the lignin binder holding the cellulose fibers of the wood together is dissolved. After cooking, the cellulose fibers, now called pulp, are separated from the spent cooking liquor in the pulp washers. After several refining processes, this pulp then goes to the paper machine to be made into paper. The spent cooking liquor with the included dissolved lignins from the wood is called black liquor. This liquor is burned in specially designed furnaces and steam is generated in boilers not too dissimiliar to central-station-design units. Smelt from the furnace is recovered and chemically treated. The smelt, now in the form of "green liquor," is returned to the digesters to be used again in the process.

Mr. Allen, by means of diagrams, pictures, and tables, gives a comprehensive description of the recovery units used for the utilization of this fuel and the recovery of the smelt. He emphasizes the remarkable progress made in this field in the past ten years.

Mr. Allen is a staff engineer with the Babcock and Wilcox Company, New York, N. Y., with whom he has been associated since his graduation from University of Colorado in 1936.

A. J. H.

Metropolitan Juniors Hear About Machine-Tool Industry

AT a meeting sponsored by the Metropolitan Junior Group of the ASME, 50 junior and student members met in the Engineering Societies Building, Jan. 12, 1948, to hear B. P. Graves, member ASME, director of design, Brown and Sharpe Manufacturing Company, Providence, R. I., speak on "Mechanical Design as It Concerns the Junior Engineer."

Mr. Graves, who has been in tool-design work for 43 years, emphasized the three following basic considerations for junior and student engineers: natural ability for design work, good education in engineering fundamentals, and imagination and vision.

Mr. Graves traced the junior engineer's career through the machine-tool industry from an apprenticeship on the drafting board or in the shop to sales engineering and management. He told of the many departments in his company and similar organizations which offer opportunities in different types of work and managerial positions.

Mr. Graves enlivened his talk with many interesting personal experiences. He pointed out the need to convince management of the necessity of taking initial steps to start production of new machines. He displayed models, use of which, he said, was one of the practical ways of doing this.

M. E. F.

Suggested Reading

A Rebel Yells

THE young engineer does well to listen carefully when a man, successful in his

field and advanced in his thinking, gives his observations on current and common problems. In this book,[1] H. Frederick Willkie, an engineer with wide experience, and currently vice-president of Joseph E. Seagram and Sons, discusses problems involved in adjusting American industry's thinking to fit a world increasingly peopled with state-controlled economies.

Mr. Willkie suggests several steps industry might take in order to reduce the possibility of general assumption of industrial duties by the government. This program involves changes in research and patent policies, company and worker relationships, and worker attitudes.

Study of the plan by young engineers interested in rising to the general-management level should help in planning long-range personal-development programs. Today's executives will find an able discussion of basic company policy concerning relations with and responsibilities to the employee, the community, and industry.

New Leaders Needed for Survival

Since governmental control is growing in the eyes of the people as a desirability because the government has acted more prominently than business toward filling such social wants as security, housing, and lower prices, the author feels that business needs more than advertising to save itself. Industry must lead in the filling of social needs if it is to continue to have the privilege of supplying goods and services on a free-enterprise basis.

Industry can survive, Mr. Willkie believes, if it develops leaders who think habitually in terms of change as applied to personal relationships and social needs as well as product design. New forces of employee initiative and interest then can be applied to the solution of today's problems.

Training New Leaders

The author suggests that necessary new leaders can be developed by thorough industrial training. Since college is a rough classifying process as to ability, a start can be made by screening recent graduates for potential leadership qualities and entering them on special rotation-training programs through all phases of a business. Depending on abilities and college specialties, experience in each supervisory position might vary from a few months to a few years. Those who passed through such a rotation program should be young in years, yet have acquired experience common only in today's much older executives, now retiring. Many of them would be capable of administering in any field, thus forming a pool of extra-skilled young men able to move from company to company, effecting needed changes.

During the executive-training program industry can carry out additional important social responsibilities. Training workers at company expense not only in increased job skills but for community needs as well, will tend to develop employees more nearly geared to new and younger leadership.

More Basic Research Required

Prominent among industry's needed changes is an increase in the emphasis on basic research, perhaps under the guiding hand of a presidential cabinet member—a secretary of research on a par with the Secretaries of Labor and Commerce. The now greatly depleted fund of creative thinking inherited from the sixteenth and seventeenth centuries must be restored. Considerable work also is needed to form a basis for more free intercompany exchange of patent and research information.

Changes in Supervisory Techniques

New industrial leaders should force many changes in personnel policies and methods used in supervision. These are mostly concerned with developing the interest of each employee for his work and his community.

The author anticipates that new techniques for job analysis will cultivate objective attitudes on the part of many workers about their jobs. Awakened interest by persons in the shop will result in continued development of new methods and improved ways of doing work.

Workers and supervisors must be objective about personnel relations too, Mr. Willkie points out. The "first lesson a man must learn in industry is that of making adjustments to the persons with whom he works." Every opportunity should be taken to develop the individual, yet groups should not be broken down, but encouraged. Group action will often easily introduce a new way of operating where an individual, promoting the same system, might fail. As the author points out, industry is frequently more social, in many important aspects, than economic.

Supervisors who carefully and continually analyze the people whose activities they direct will more easily gain the confidence of the group. Development of initiative and reward of its demonstration by social recognition and friendliness, in addition to a $2-a-week raise, are responsibilities to which supervisors must devote considerable time.

Avoid Expertism

Mr. Willkie decries present industrial practice which tends to keep a man in a supervisory or staff job, narrow in scope, until his thinking is limited to that field and he becomes an "expert," frustrated in his present assignment and unqualified to move higher in the organization, or, if he is moved, incapable of properly performing broader duties demanded of him.

The author's solution to the problem of expertism is consistent with the major points stressed throughout the book: broad training and job rotation so that all employees may be taught adaptability to change and be kept abreast of developments in company and community interests outside of their jobs.

In today's world, when many still look forward to a postwar return to many prewar business and social conditions, Mr. Willkie's emphasis upon planning for continual change seems particularly timely.

PRESTON D. CARTER.[2]

[1] "A Rebel Yells," by H. Frederick Willkie, D. Van Nostrand Company, Inc., New York, N. Y. 1946, cloth, $5^3/_4 \times 8^1/_2$ inches, 311 pp., $3.

[2] Mem. ASME, Manager of Planning and Control, Kalamazoo Vegetable Parchment Company, Kalamazoo, Mich.

Letters

More Junior-Senior Contacts Needed

To the Editors:

I READ with interest the discouraged attitude of your article "The Ball Hits a Bump." It seems that you are expecting too much from the juniors on short notice. As fellow junior Roy W. Vorhees, Jr., states in the start of his letter, "The birth . . . is a . . . surprise for us neophytes. The 'forgotten man' comes into his own." It is certainly a step in the right direction by the elders of the organization but much more will have to be done by the members as well as the juniors to overcome the past years of inactivity.

I was gratified to obtain the Junior Group manual, "It's Up to You," and to read of the suggested activities for junior participation. In the accompanying letter, President O'Brien stated that it was established that the juniors "are at a loss how to proceed" to become more active in Society affairs. This is very true, but it seems to me that such ideas as are set forth in the pamphlet will increase the junior's activity. It will tend to continue and widen the schism between the senior and junior members. My opinion, which I believe is shared by many juniors, is that the junior does not wish to mix only among juniors, but that he wishes to come in closer contact with the older members so that he may derive certain benefits from their experiences, and to enrich his business education by the useful contacts which he can make. While the creation of Junior Groups will certainly be beneficial, I think that a further step should be taken to encourage a fuller activity of the juniors among the groups that are already set up.

CHARLES T. MILLER.[3]

A Suggestion

To the Editors:

The "Junior Forum" is a potential source of valuable information for both junior and student members of the ASME. As the "Forum" progresses, I hope for increased participation by the more experienced members of our Society.

Since many young men are not certain which phase of engineering they are best suited for, I believe a monthly career counsel would be very useful.

Specifically, I suggest that an experienced mechanical designer or labor-relations man, for instance, write several paragraphs concerning his position and its problems. To my mind, the article should discuss the following factors: (1) Aptitudes and temperaments desirable for the particular position; (2) advantages and disadvantages, both business and domestic, concomitant with the work; (3) ad-

[3] Jun. ASME, Mechanical Engineer, Jackson and Moreland, Park Square Building, Boston, Mass.

visability of graduate study in preparing for the field; and (4) thoughts on gaining applicable experience for the situation discussed.

If other juniors and students will add to this list, the editorial board will discover what we want to know about the various engineering positions. A well-written article based upon the best ideas submitted would be carefully read each month by many of us. Such a feature will lend real assistance to the man deciding upon his industrial career.

ROBERT A. FISCHER.[4]

ASME Sponsors Safety Code for Industrial Power Trucks

THE American Society of Mechanical Engineers has been designated sole sponsor under the procedure of the American Standards Association of a committee now being organized to formulate a safety code for industrial power trucks.

The tentative scope of the project:

"Safety requirements relating to industrial power trucks, such as platform trucks, tractors, low-lift trucks, high-lift trucks, fork-lift trucks, and special industrial trucks, but not including commercial motor vehicles intended for use upon land highways; these safety requirements to include such factors as operating controls, brakes, steering stability while lifting and carrying loads, maneuverability, etc."

As sole sponsor of the project, the Society has invited more than 35 national trade and professional organizations representing manufacturers, employers, labor unions, insurance companies, independent specialists, government agencies, and others who have an interest in industrial power trucks to participate in the writing of the projected safety code.

[4] Jun. ASME, Mechanical Engineer, Associated Factory Mutual Fire Insurance Companies, Worcester, Mass.

International Conference on Surface Reactions

THE Pittsburgh International Conference on Surface Reactions will be held at the Mellon Institute for Industrial Research in Pittsburgh, June 7–11, 1948.

Preliminary plans call for technical sessions mornings and evenings and visits in the afternoons to Pittsburgh research laboratories which are working on surface reactions.

Scientists, engineers, and educators from many parts of the world have been invited to participate in the conference and several will present papers.

The Conference Committee is made up of the following: Earl Gulbransen, Westinghouse Research Laboratories, chairman, representing The Electrochemical Society, Pittsburgh Section; D. S. McKinney, Carnegie Institute of Technology, representing The University Conference on Corrosion and Metal Protection; Mars Fontana, Ohio State University, representing The Electrochemical Society, Corrosion Division; J. M. Bialosky, Research Laboratory, Carnegie-Illinois Steel Company, representing The National Association of Corrosion Engineers; J. W. Hickman, Westinghouse Research Laboratories, representing The Pittsburgh Physical Society; C. Pogocar, Mellon Institute for Industrial Research, representing The American Chemical Society, Pittsburgh Section; Richard Rimbach, Member ASME Corrosion Publishing Company, representing *The Corrosion Forum*.

Actions of the ASME Executive Committee

At a Meeting Held at Headquarters, Jan. 16, 1948

THE meeting of the executive committee of the Council was held in the rooms of the Society, January 16, 1948. There were present: E. G. Bailey, chairman, F. S. Blackall, Jr., F. M. Gunby, J. N. Landis, T. E. Purcell, of the executive committee, E. J. Kates and A. R. Mumford, members of the Council, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

New Publications Plan

A recommendation of the Publications Committee to the effect that no further changes to the new publication plan be made until its operation can be observed for one year, was noted. Following a report by the secretary that members in England have written describing the hardships caused by the new plan, the Publications Committee was requested to review the new plan from the point of view of all foreign members.

Resolution of Thanks

The secretary was instructed to extend the thanks and appreciation of the Society to the ASME Philadelphia Section and all who contributed to the success of the 1947 Annual Meeting.

Milwaukee Section

Following a review of the action of the vice-president's meeting of Dec. 2, 1947, which approved a proposed affiliation contract between the ASME Milwaukee Section and the Engineers Society of Milwaukee, the committee requested that a clause be added to the contract calling attention to the fact that the contract constitutes an obligation of the Section rather than of the Society as a whole.

Constitutional Convention

Following a review of comments on the report of the EJC Committee on the Organization of the Engineering Profession, it was agreed that the time was not opportune for the formation of the National Engineering Council and that the Society should increase support of the Engineers Joint Council, promote the organization of the engineering profession at the local level, and defer the calling of any constitutional convention until a need for such a convention was more definitely indicated.

Erie Section

An affiliation agreement between the ASME Erie Section and the Erie Engineering Societies' Council was approved, subject to the rules of the Society which provide that the annual payment is an obligation of the Section rather than of the Society as a whole.

Naval Academy Student Branch

A letter-ballot approval of the establishment of an ASME Student Branch at the Midshipman School of the U. S. Naval Academy, Annapolis, Md., was confirmed.

Certificates of Award

Approval of Certificates of Award by President E. G. Bailey for the following retiring chairmen was noted: A. M. Gompf, Constitution and By-Laws; W. H. Sawyer, Finance, E. F. Church, Jr., Library; Harry W. Gabor, Safety; William C. Mueller, Sectional Committee on Small Tools and Machine-Tool Elements.

Communication to President Truman

The EJC communication to President Truman signed by the presidents of the constituent societies requesting favorable action on science legislation, was noted.

Death of C. B. Le Page

With deepest sorrow the committee learned of the sudden death on Jan. 15, 1948, of Clifford B. Le Page, assistant secretary of the Society for 28 years.

Appointments

Appointments to Boards, committees, and joint activities recommended by the Organization Committee were approved. The list of these appointments was published in the February issue of Society Records, copies of which may be obtained by writing to Headquarters.

Books for Mechanical Engineers, 1947

THIS list of some important books of interest to mechanical engineers has been compiled by the staff of the Engineering Societies Library. The books were selected from those added to the Library during 1947. Some equally good books may have been omitted but the desire for a short list has forced us to choose rather than to include all.

INVENTIONS AND THEIR MANAGEMENT, by A. F. Berle and L. S. De Camp. Second edition. 742 pp. 1947. International Textbook Co., Scranton, Pa. $6. This comprehensive work presents the principles and practices governing the technical, legal, and business procedures of invention, from the history and theory of the

protection of ideas to the methods of exploitation.

Conduction of Heat in Solids, by H. S. Carslaw and J. C. Jaeger. 386 pp. 1947. Oxford University Press, London, $8. Based on the earlier "Introduction to the Mathematical Theory of Conduction of Heat in Solids," this volume has been rewritten and brought up to date.

Compressed Air Handbook, Applications, Equipment, Engineering Data, and Test Procedure. 387 pp. 1947. Compressed Air and Gas Institute, 90 West Street, N. Y., $3. An authoritative guide for the proper installation, use, and maintenance of air compressors and air-actuated equipment.

Technology of Adhesives, by J. Delmonte, 516 pp. 1947. Reinhold Publishing Corp., N. Y., $8. Covers all types of adhesives, with special emphasis on synthetic-resin plastics; deals with their chemistry, formulation, and use with various types of materials.

Examination of Industrial Measurements, by J. W. Dudley, Jr. 113 pp. 1946. McGraw-Hill Book Co., N. Y., $2. Acquaints engineers with simple and adaptable statistical techniques for the detection of variation in industrial products; provides simple tools for construction-control charts, making quartile analyses and analyzing limitations of data curves.

Science and Engineering of Nuclear Power, by C. Goodman, editor. Vol. I. 503 pp. 1947. Addison-Wesley Press, Inc., Cambridge, Mass., $7.50. Covers the basic treatment of nuclear-pile design and its practical application, in addition to background material necessary for their understanding; allied subjects such as control, monitoring chemistry of heavy elements, and fission products are also treated. Volume II in preparation.

Industrial Applications of Infrared, by J. D. Hall. 201 pp. 1947. McGraw-Hill Book Co., N. Y., $4. Written from a practical point of view, this up-to-date manual shows the executive, supervisor, plant engineer, etc., how to use infrared radiation to achieve better and more economical surface finishes and how to apply it to other industrial heating jobs. Covers the use of infrared heat in metalworking, wood finishing, textiles, paints, paper, plastics, and ceramics.

Rotary Valve Engines, by M. C. I. Hunter. 216 pp. 1946. Hutchinson's Scientific and Technical Publications, London, 21s. Gives general principles, development, and applications of the rotary valve in detail and draws comparisons between it and the poppet valve for use on internal-combustion engines.

Explosion and Combustion Processes in Gases, by W. Jost. Translated from the German by H. O. Croft. 621 pp. 1946. McGraw-Hill Book Co., N. Y., $7.50. A translation of a classic German work; provides a broad theoretical basis as well as a detailed description of experimental work; important topics covered include spark ignition, the propagation of explosions, detonation, flame temperatures, kinetics of processes involved, combustion of oxygen-hydrogen mixtures, and combustion of hydrocarbons.

Servomechanism Fundamentals, by H. Lauer and others. 277 pp. 1947. McGraw-Hill Book Co., N. Y., $3.50. Gives the principles underlying the theory of servomechanisms, discusses their operating features, and sets forth systematic procedures for the design of such devices.

Human Factors in Air Transport Design, by R. A. McFarland. 670 pp. 1946. McGraw-Hill Book Co., N. Y., $6. Presents factual information on all aspects of air-transport design influencing those who operate the planes or travel by air; furnishes the interpretive background necessary to show how a given physical variable creates a human problem, and offers recommendations or possible solutions concerning the human factors in air-transport design.

Escalator Method in Engineering Vibration Problems, by J. Morris. 270 pp. 1947. John Wiley & Sons, N. Y., $4.50. The escalator process, devised for the solution of Lagrangian frequency equations, makes it possible to solve a complicated system in a simple manner by dealing with its constituent parts. The solution of each of these parts is made available with appropriate linkage co-ordinates or reactions. The complete system is solved in manageable form by the elimination of these linkages, furnishing an effective means for dealing with vibration problems. The book also deals with other methods of computation of structural stresses, the theory of elasticity, methods of strain energy, and least work.

Naval Machinery, 1946. 2 vol. 1946. United States Naval Academy, Annapolis, Md., vol. 1, $4; vol. 2 $4.25; vol. 1: part I, Naval Boilers; part II, Naval Steam Turbines. Vol. 2, part III, Naval Auxiliary Machinery, part IV, Naval Reciprocating Steam Engines.

Writing the Technical Report, by J. R. Nelson. Second edition. 388 pp. 1947. McGraw-Hill Book Co., Inc., New York, N. Y., $3. Presents a review of those fundamental considerations which bear on the design and composition of the report, gives specific directions for the setup, outlines a systematic procedure for critical examination, and suggests a series of assignments for those who wish to make use of the book as a classroom text.

How to Take Physical Inventory, by R. F. Neuschel and H. T. Johnson, 159 pp. 1946. McGraw-Hill Book Co., Inc., New York, N. Y., $2. Sets forth the steps to be taken and the considerations to be weighed in preparing for a physical inventory, and contains a manual of inventory instructions that has successfully met the test.

Panel Heating and Cooling, by B. F. Raber and F. W. Hutchinson. 208 pp. 1947. John Wiley & Sons, N. Y., $3.50. The first four chapters present nontechnical, descriptive material on the background, development, advantages, disadvantages, and types of installation; the second and largest section, Chapters V to XI, contains a detailed and rigorous treatment of the theory of radiant exchange and the mathematical analysis of panel systems; the last two chapters discuss simplified design procedure.

Advanced Mathematics for Engineers, by H. W. Reddick and F. H. Miller. Second edition. 508 pp. 1947. John Wiley & Sons, N. Y., $5. Assuming a knowledge of mathematics through calculus, the authors deal with various special functions, integrals, series, and equations, vector analysis, probability, and the operational calculus; problems are presented to emphasize physical application in the main fields of engineering.

Control Charts in Factory Management, by B. Rice, 149 pp. 1947. John Wiley & Sons, N. Y., $2.50. The underlying theory of statistical control is first discussed, followed by practical information concerning its proper and effective use; intended particularly for the business or factory executive, the book should be of equal value to those who have the direct responsibility of such work.

Plastics Mold Design, by C. C. Sachs and E. H. Snyder. 77 pp. 1947. Murray Hill Books, N. Y., $4.50. Part I briefly covers drafting-room practice and materials for mold construction; part II takes up the actual design procedures for compression molding, transfer molding, injection molding, and extrusion dies, including the causes and remedies of faults; a pocket at the back of the book contains a group of full-sized, completely dimensioned working drawings of plastic molds for the use of the student, engineer, or designer.

Plastics Handbook for Product Engineers, by J. Sasso, 468 pp. 1946. McGraw-Hill Book Co., N. Y., $6. Brings together practical and fundamental data on plastics and synthetic rubber for designers and engineers who want complete facts on the suitability of these materials in new product designs.

New Fibers, by J. V. Sherman and S. L. Sherman. 537 pp. 1946. D. Van Nostrand Co., N. Y., $5. Both man-made and chemically improved natural fibers are covered; discusses the history and development, manufacture, processing, and properties of these fibers; contains a classified list of new fibers suggesting various applications, and a classified list of U. S. patents issued in the last ten years.

Technology of Industrial Fire and Explosion Hazards, by R. C. Smart. Vol. I. 202 pp. vol. II, 184 pp. 1947. Chapman & Hall, Ltd., London, 16s each. Fire wastage and research are dealt with in volume I, as well as the thermal reactions of materials and fire risk with agricultural products, coal, industrial fuels, and gases. Hazards with light alloys, light-alloy dust explosions, and explosive dusts produced in industry are considered. New materials, techniques, and processes are discussed in volume II. Dangers due to toxic gases and the use of self-contained breathing apparatus are examined, while electrical fires and explosions due to static electricity and lightning are given close attention. The broad coverage of these two volumes should make them of interest in a wide field of industrial and insurance work.

SOME OF THE 200 MEMBERS AND GUESTS AT THE ASME OREGON SECTION DINNER MEETING HELD IN THE CHAMBER OF COMMERCE HALL, PORTLAND, ORE., JAN. 14.

Section Activities

Record Meeting Held by Oregon Section

MORE than 400 engineers and students responded to an invitation from the ASME Oregon Section to inspect the heating and ventilation installation in the Equitable Building, Portland, Ore., Jan. 14, 1948. This installation now being completed is one of the largest heat-pump installations in the United States. Among the guests were members of the American Society of Civil Engineers, American Institute of Architects, and 30 students and members of the faculty of the Oregon State College, who drove 90 miles in bad weather to inspect the plant.

Preceding the inspection tours, a dinner meeting was held at which J. Donald Kroeker, designer of the Equitable Building installation, was the main speaker. Mr. Kroeker discussed the problems involved in the design of the plant and demonstrated the practicability of the application of the heat pump to space heating of commercial buildings. An effective speaker, Mr. Kroeker's talk was nontechnical and well illustrated. So interesting was his talk that he has been invited to speak on the same subject before a joint meeting of the Founder Societies' student branches at the Oregon State College in the near future.

AT THE ASME OREGON SECTION JAN. 14 MEETING

(*Left to right:* A. A. Osipowich, program chairman, J. Donald Kroeker, speaker, and George Joost, chairman, ASME Oregon Section.)

The inspection tours, conducted at 15-minute intervals, continued well into the night. A. A. Osipovich, U. S. Department of the Interior, Portland, Ore., was chairman of the program committee.

Brief reports of other ASME Section meetings follow:

Akron-Canton

Dec. 18, Cuyahoga Falls High School Auditorium, Cuyahoga Falls, Ohio. Speaker: Capt. H. E. Saunders, U.S.N. Subject: Model Basin Testing as Related to U. S. Navy Superiority. Attendance: 88.

Jan. 15. Inspection trip to the plant of the Hoover Company, followed by movies on the history of the company. Attendance: 34.

Anthracite-Lehigh Valley

Jan. 23, Lehigh University, Bethlehem, Pa. Speaker: J. William Putt. Subject: Dual-Engine Truck Design. Attendance: 43.

Boston

Jan. 22, Hotel Commander, Cambridge, Mass. Speaker: E. G. Bailey, president ASME. Subject: The Engineers' Opportunities. Attendance: 260, including 100 students, guests of the Section at the dinner preceding the meeting. President Bailey presented a 50-year medal to Henry Bartlett, member ASME.

Central Indiana

Jan. 16, Atheneum Club, Indianapolis, Ind. Speaker: Dr. Marvin Mundel, junior member ASME, associate professor industrial engineering, Purdue University. Subject: Design Engineer's Place in the Motion-Study Program. Attendance: 43.

Central Iowa

Jan. 21, Iowa State College, Ames, Iowa. Speakers: Russell Parrish, John Hill, and H. L. Mason. Subjects: Annual Meeting ASME, Atlantic City, N. J., in December, 1947; Place of the Design Engineer in Industry; Three Basic Types of Printing. Attendance: 32.

Chicago

Jan. 16, Peoples Gas Light and Coke Auditorium, Chicago, Ill. Speaker: T. B. Jefferson, editor of *The Welding Engineer.* Subject: What the Future Holds for Welding. Attendance: 126.

Dayton

Jan. 28. Inspection trip and dinner, Frigidaire Division, Plant No. 2, auditorium, General Motors Corporation. Speaker: F. Howard McCormick, assistant chief engineer, Frigidaire Division, General Motors Corporation. Subject: The Development of the Frigidaire Automatic Washer.

Detroit

Dec. 18, Rackham Building, Detroit, Mich. "National Society Affairs" Meeting. Speaker: E. G. Bailey, president ASME. Subject: The Engineers' Opportunities. Guests: Student branches of University of Detroit, University of Michigan, Michigan State College, and Wayne University. Attendance: 230.

Jan. 21, Rackham Building, Detroit, Mich. Speaker: Dr. A. C. Fieldner. Subject: "The Future Fuel Supplies." Attendance: 600.

Fairfield County

Jan. 21, Hotel Barnum, Bridgeport, Conn. Speaker: Prof. E. M. Kemler, New York University, New York, N. Y. Subject: Heat Pump. Attendance: 75.

E. G. BAILEY, PRESIDENT ASME, ADDRESSING A MEETING OF THE DETROIT SECTION ON DEC. 18, 1947

Hartford

Jan. 20, City Club, Hartford, Conn. Speaker. Joseph P. Granfield, United Aircraft Corporation. Subject: Jet and Gas-Turbine Power for Aircraft. Attendance: 90.

Metropolitan

Jan. 21, Engineering Societies Building, New York, N. Y. Speaker: Howard Dimmig, vice-president, Hydrocarbon Research, New York, N. Y. Subject: Synthetic Gasoline. Attendance: 200.

Mid-Continent

Jan. 29, Mayo Hotel, Tulsa, Okla. Speaker: Dr. Arthur E. Focke, chief metallurgist, Diamond Chain and Manufacturing Company. Subject: Manufacture and Metallurgy of Roller Chains. Attendance: 60.

Milwaukee

Jan. 14, City Club, Milwaukee, Wis. Speaker: W. F. Shurts, chief engineer, Twin Disc Clutch Company, hydraulic division, Rockford, Ill. Subject: Hydraulic Couplings and Torque Converters. Attendance: 98.

North Texas

Jan. 20, Dallas Power and Light Building, Dallas, Texas. Speaker: J. R. Darnell, member ASME, Westinghouse Electric Company. Subject: Design, Application, and Performance of Fans. Attendance: 30.

Ontario

Jan. 8, Hart House, University of Toronto, Toronto, Ont., Can. Speaker: D. G. Shepherd. Subject: Combustion for the Gas Turbine. Attendance: 150.

Oregon

Dec. 19, board room, Public Service Building, Portland, Ore. Speaker: Paul L. Heslop, member ASME, consultant on construction for the Brazilian Affiliates, Electric Bond and Share Company. Subject: The Industrial High Lights of Brazil. Attendance: 22.

Peninsula

Jan. 20, Grand Rapids, Mich. Speaker: Prof. Lester S. O'Bannon, member ASME, University of Michigan. Subject: Synthesis of Business Cycles. Attendance: 24.

Philadelphia

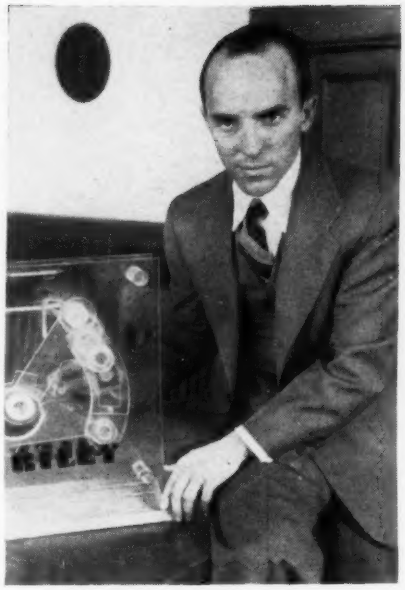
Dec. 16, University of Pennsylvania, Philadelphia, Pa. Speaker: Arnold H. Redding, junior member ASME. Subject: Future Forms of Aviation Gas Turbines. Attendance: 71.

Jan. 20, University of Pennsylvania, Philadelphia, Pa. Speaker: Malcolm F. Judkins, member ASME, chief engineer, Firthite Division, Firth-Sterling Steel Company, McKeesport, Pa. Subject: Carbide Tools, Dies, and Wear-Resistant Applications. Attendance: 37.

Jan. 27, Engineers Club of Philadelphia, Philadelphia, Pa. Speaker: C. A. Reed, member ASME. Subject: A Survey of Germany's Power Plants and Fuels Used. Attendance: 67.

St. Joseph Valley

Jan. 20, Hotel Mishawaka, Mishawaka, Ind. Speaker: Emmett C. Belzer, Bell Telephone Company. Subject: Communications. Attendance: 36.



EARLE C. MILLER, MEMBER ASME, WORCESTER SECTION

(First recipient of the Admiral Ralph Earle Award for 1947. This award is made each year to the engineer, under 35 years of age, residing in Worcester County, Mass., who during the year has made a significant engineering contribution. The award consists of a medal, a certificate of meritorious achievement, and the sum of one hundred dollars. Mr. Miller, who is design engineer of the Riley Stoker Corporation, was chosen to receive the award for his engineering work on the development and design of Riley Spreader Stokers. The award was presented at the Dec. 8, 1947, meeting of the Worcester Engineering Society.)

St. Louis

Jan. 23, Garavelli's Restaurant, St. Louis, Mo. Speaker: B. J. Fletcher, chief engineer, development division, Aluminum Company of America. Subject: Aluminum Alloy Piping. Attendance: 48.

Southern Tier

Jan. 6, mechanical laboratory, Cornell University, Ithaca, N. Y. Speaker: Donald P. Eckman, junior member ASME. Subject: Air-Operated Mechanisms. Attendance: 15.

South Texas

Jan. 21, Houston Engineers Club, Houston, Texas. Speaker: Prof. Carl W. Files, junior member ASME, A & M College of Texas. Subject: Supersonic Flow. Attendance: 61.

Syracuse

Dec. 18, Technology Club, Syracuse, N. Y. Speakers: William Etherington and Elton Bischoff, student engineers, Syracuse University. Subject: Airplanes. Attendance: 41.

Trenton

Jan. 19, Carteret Club, Trenton, N. J. Speaker: Prof. Paul B. Eaton, member ASME, head, mechanical-engineering department, Lafayette College, Easton, Pa. Subject: Lifetime-Continued Education of the Engineer. Attendance: 19.

Washington

Jan. 7, Engineers Club, Seattle, Wash. Speaker: Prof. E. Paul De Garmo, member ASME, associate professor of mechanical engineering, University of California, Berkeley, Calif. Subject: What We Have Learned From Our Study of Residual Welding Stresses. Attendance: 76.

Worcester

Jan. 8, Worcester Polytechnic Institute, Worcester, Mass. Speaker: Charles J. Hudson, quality-control manager, Norton Company. Subject: Quality Control. Attendance: 40.

Student Branch Activities

Alabama Polytechnic Institute

Dec. 1, Ramsey 200, James Burson, chairman, presiding. The chairman announced that the magazine *Auburn Engineer* will be published. Election of officers. Attendance: 50.

University of Arizona

Jan. 6, Engineering Building. Speaker: Willis Barne, former graduate of the University. Subject: Refrigeration. Mr. Barne also discussed the training course given by the York Ice Machinery Company of York, Pa. Attendance: 30.

Jan. 8, Administration Building. Program: Films made by Fellows Gear Shaper Company, Springfield, Vt., The Art of Generating, and Gear-Manufacturing Equipment. Attendance: 50.

Bucknell University

Dec. 18, Hotel Lewisburger, Lewisburg, Pa., steak banquet. Speaker: William M. Sheehan, Fellow ASME, vice-president, General Steel Castings Corporation, Eddystone, Pa. Subject: Trip to the Union of South Africa. Attendance: 64.

Catholic University

Jan. 20, Washington, D. C. Speaker: Henry H. Snelling, past vice-president ASME, consulting engineer, Snelling and Hendricks, Washington, D. C. Subject: Patent Engineering. Attendance: 15.

Carnegie Institute of Technology

Dec. 9. Joint meeting of six engineering societies of the Institute. Speaker: Capt.

SENIOR UNDERGRADUATES OF THE ASME STUDENT BRANCH OF PRATT INSTITUTE

H. N. Wallin, U. S. Navy. Attendance: 400.

Jan. 22. Speaker, E. W. Jacobson, member ASME, chairman of Pittsburgh Section. Program: Film by Combustion Engineering Company, Inc., "Steam Progress."

Jan. 29, annual graduation dinner. Speaker: P. J. Utnehmer, Babcock and Wilcox Company. Subject: What Industry Looks for in the New Engineers.

University of Colorado

Jan. 28, Engineering Administration Building. Speaker: R. T. McCalmon, Boyers Manufacturing Company. Subject: Radiant Heating, illustrated with slides; also film entitled "Eternally Yours," the story of wrought iron. Attendance: 125.

Columbia University

Dec. 11. Program: B. P. Proctor, quality-control department, Johns-Manville Corporation, presented his company's color sound film on "Statistical Quality Control."

Jan. 12. Officers were elected for the spring term.

Cooper Union School of Engineering (Day)

Dec. 21, Hans Jaeger's Restaurant, New York, N. Y. Program: Annual Christmas dinner. Speaker: Prof. H. B. Hope, chemical-engineering department, Cooper Union Institute of Technology.

Jan. 20. Election of officers held for the spring term. Attendance: 40.

Clarkson College of Technology

Jan. 22. Program: Film entitled "Die Casting," product of The New Jersey Zinc Company. Attendance: 115.

University of Detroit

Jan. 6, Chemistry Building. Speaker: Tom Koebel. Subject: Problems of Living and Working on Ice-Clad Mt. Washington, N. H. Attendance: 50.

Drexel Institute of Technology

Jan. 21, Student Building. Speaker: Mr. Moxey, assistant chief engineer, automotive division, Sun Oil Company. Subject: Design of Gasolines. Attendance: 49.

Duke University

Jan. 13, J. E. Martin, presiding officer. Program: Two films, "Building the Golden Gate Bridge," and "The Making of Alloy Steel," products of Bethlehem Steel Corporation. Announcement of contest to be held by *Duk-Engineer* for outstanding papers.

University of Florida

Jan. 8, Temporary Building F, room 101. Walter B. King, Jr., presiding officer. Election of officers held. Program: Technicolor motion picture "Steam Progress." Attendance: 34.

George Washington University

Jan. 7, Government Building, room 101. Speaker: Charles F. Kottcamp, member ASME, assistant to director of research, Locomotive Development Committee, Bituminous Coal Research, Inc. Subject: The Coal-Burning Gas-Turbine Locomotive. Attendance: 60.

Georgia School of Technology

Jan. 13, Mechanical Engineering Building. Presiding officer: E. R. Du Bose. Speaker: Prof. W. A. Hinton, member ASME, honorary chairman. Subject: ASME Principles, Practices, and Advantages to Prospective Members. Attendance: 93.

Jan. 20, Mechanical Engineering Building. Speaker: Mr. Fair, New Departure Ball Bearing Company. Subject: Manufacture of Ball Bearings, illustrated with film showing manufacture. Attendance: 94.

Jan. 27, Mechanical Engineering Building. Speaker: W. J. Campbell, welding specialist, General Electric Company. Subject: Talk and film on Electric Welding, Design, and Use. Attendance: 94.

University of Idaho

Dec. 15, Engineering Building. Speaker: R. H. Allen, Aqua Heating Company, Seattle, Wash. Subject: Radiant Heating. Attendance: 60.

Illinois Institute of Technology

Jan. 13, North Union Building, I. C. Hamilton, presiding officer. Election of officers. Attendance: 50.

Johns Hopkins University

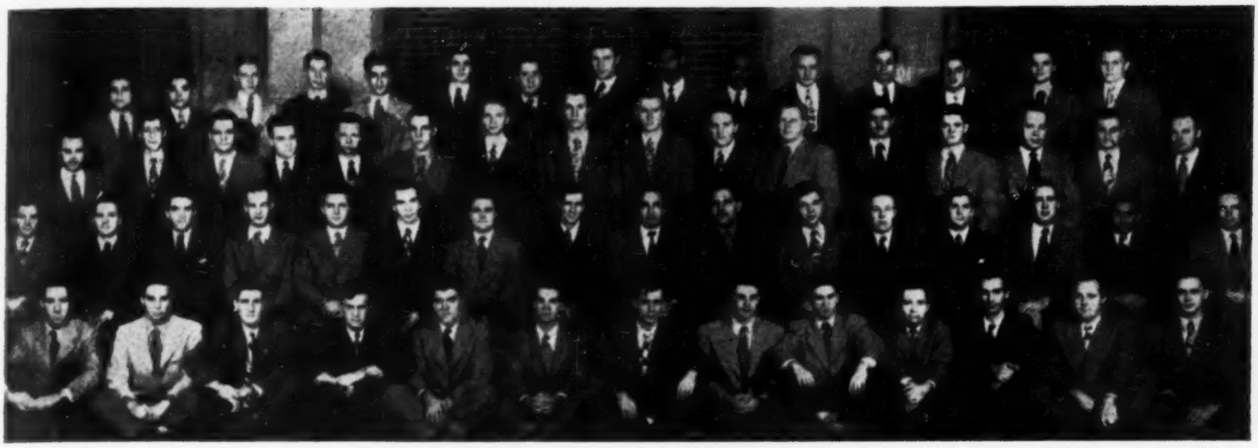
Jan. 16, Paul Flynn, presiding officer. Program: Two reels of movies dealing with the manufacture of copper, its alloys, and magnesium, product of the Revere Copper and Brass Company. Attendance: 45.

University of Kansas

Jan. 13, Lindley Auditorium. Speaker: Mr. Klein, consulting engineer, Mackie-Clemens Fuel Company, Pittsburgh, Kan. Subject: Coal Production and Uses. Attendance: 70.

1948 ASME Regional Student Conferences

	Region	*Host*	*Place*	*Date*
I	New England	University of Maine	Orono, Maine	May 7–8
II	Eastern	College of the City of New York	New York, N. Y.	May 1 or 8 (Tentative)
III	Alleghenies	Lehigh University	Bethlehem, Pa.	April 16–17
IV	Southern	University of Florida	Savannah, Ga.	April 5–6
V	Midwest	Michigan State College	East Lansing, Mich.	April 26–27
VI	Northern Tier	University of Wisconsin	Madison, Wis.	May 10–11
VI	Southern Tier	University of Iowa	Davenport, Iowa	April 18–20
VII	Pacific N.W.	Washington State College and University of Idaho	Pullman, Wash.	May 5–8
VII	Pacific S. W.	California Institute of Technology	Pasadena, Calif.	April 23–24
VIII	Northern	Oklahoma A & M College	Tulsa, Okla.	May 14–15
VIII	Southern	Texas, A & M College of	College Station, Texas	April 12–13
VIII	Rocky Mountain	University of New Mexico	Albuquerque, New Mexico	April 23–24



ASME STUDENT BRANCH OF THE UNIVERSITY OF MICHIGAN

University of Kentucky

Dec. 12, Memorial Hall, in conjunction with the general Engineering Convocation. Speaker: Prof. Russel A. Dodge, professor of engineering mechanics, University of Michigan. Subject: The Principles of Fluid Flow.

Jan. 15, Training School Auditorium, J. L. Morrissey, presiding officer. Program: Film on "Diesel Engines." Attendance: 292.

Jan. 22, Training School Auditorium. Speaker: S. D. Fulton, Westinghouse Corporation. Subject: Gas and Steam Turbines.

Jan. 29, Training School Auditorium. Speaker: Kendall Weisiger, Bell Telephone Company. Subject: The Engineer as an Administrator.

Lafayette College

Jan. 8, Mechanical Laboratory, John S. Trogner, presiding officer. Officers for the spring term were elected. Speaker: Herbert Levin, mechanical-engineering student from the senior class. Subject: Make It Look Good. Program also included showing of Kodachrome motion-sound picture "Die Casting," product of the New Jersey Zinc Company.

Michigan State College

Jan. 27, Olds Hall, room 111. Speaker: George Sandburn, chief field engineer, Fellows Gear Shaper Company. Subject: Gear Manufacturing and Development of the Involute by a Reciprocating Cutting Tool. Attendance: 69.

University of Michigan

Dec. 17, 1947, Michigan Union. Annual "Spoofuncup" banquet. Guests: Four professors representing the engineering-mechanics, mechanical-engineering, and metal-processing departments. Prof. E. T. Vincent of the mechanical-engineering department was chosen as the "spoofingest" professor and awarded the "spoofuncup" for the year. Attendance: 62.

Jan. 7, Michigan Union. Program: Three movies, "Looking Through Glass," a short on the British glass industry; "Powder Metallurgy," and "Die Casting." Attendance: 112.

University of Minnesota

Jan. 14, Coffman Memorial Union. Program: Two films, "Unfinished Rainbows," the story of aluminum; and "Prospecting for Petroleum."

Jan. 28, Coffman Memorial Union. Program: Talks by student members Frank Beery, Bob Montague, Bob Ernt, and Gordon Wickre.

University of Missouri

Jan. 15, temporary classroon T-4. Speaker: Dr. Scorah, chairman of the mechanical-engineering department. Subject: Senior inspection trip. Walter Roesener was elected chairman for the winter semester. Attendance: 76.

University of Nebraska

Dec. 17, Richards Laboratory, room 206, annual joint meeting with Nebraska Section ASME. Speaker: Prof. Wm. L. De Baufre, Fellow ASME, chairman of the department of engineering mechanics, University of Nebraska. Subject: Manufacture of Oxygen. Attendance: 123.

ASME STUDENT BRANCH OF THE UNIVERSITY OF NEBRASKA

Jan. 14, Richards Laboratory, room 206, James Jensen, presiding officer. Officers for the spring semester were elected. Speaker: Prof. N. H. Barnard, member ASME, chairman, mechanical-engineering department, University of Nebraska.

Subject: Student Papers. Program: Two films, "Aerodynamics of Airfoil," and "Flying." Attendance: 56.

University of Nevada

Dec. 17, New Engineering Building, Mr. Coe, presiding officer. Speakers: Student members who gave talks on gas turbine, jet engine, and pulse engine. Program: Motion picture showing aircraft take-off assisted and unassisted by rockets and jet units. Attendance: 18.

Jan. 14, Engineering Building, Charles Coe, presiding officer. It was decided to elect officers annually rather than before each semester. Program: Film "Jet Propulsion," product of General Electric Company by the Walt Disney Studios. Attendance: 34.

New York University (Day)

Jan. 6, University Heights campus. Speaker: Merrill C. Horine, sales-promotion manager, The Mack-International Motor Truck Co., New York, N. Y. Subject: Automotive Diesels. Attendance: 60.

Northeastern University

Jan. 8, Botolph Building, Francis J. Callahan, presiding officer. Officers elected for the term February, 1948, to October, 1948. Attendance: 40.

University of Oklahoma

Dec. 17, Engineering Auditorium, joint meeting with AIEE. Officers of the AIEE presided. Speakers: W. B. Clayton, commercial vice-president, General Electric Company, and L. T. Blaisdell, also a vice-president of General Electrical Company. Subject: The speakers' experiences from engineer trainee to executive with the General Electric Company. Attendance: 300.

Jan. 7, Engineering Auditorium, Robert M. Wright, presiding officer. Speaker: Frank S. Roop, Jr., junior member ASME. Subject: Mid-Continent Section meeting, and coming district meeting of Region VIII. Program: A movie on steam turbines by Allis-Chalmers Manufacturing Company. Attendance: 24.

OFFICERS OF STUDENT BRANCH OF QUEENS UNIVERSITY

(*Left to right:* W. Sutherland, chairman; M. Campbell, treasurer; Prof. H. G. Conn, honorary chairman; J. Williams, vice-chairman; J. Smythe, secretary)

Ohio State University

Dec. 4, Robinson Laboratory, Ralph Stimson, presiding officer. Program: Movie on Aluminum. Attendance: 60.

Jan. 15, Robinson Laboratory. Election of officers held. Program: Technicolor movie "Blowpipes," which portrayed the history of glassmaking and its development through the ages. Attendance: 102.

Jan. 29, Social Administration Building Auditorium. Guests: ASME Columbus Section. Speaker: H. A. Ingram, Babcock & Wilcox Company, who commented on operations shown in a movie "Steam Power for American Sea Power." Attendance: 105.

University of Pittsburgh

Jan. 15, Cathedral of Learning. Speaker: Prof. G. O. Manifold, junior member ASME, honorary chairman. Subject: Address to the graduating seniors on advantages and reasons for transferring from student membership to junior. Election of officers for the spring semester was held. Attendance: 177.

Polytechnic Institute of Brooklyn

Dec. 16, Joseph Turchiano, presiding officer. Speaker: J. N. Landis, director at large, ASME, Consolidated Edison Company of New York, N. Y. Subject: The Engineer, His Society, and His Potentialities. Attendance: 90.

Purdue University

Dec. 16, Electrical-Engineering Building. An oil painting by Rockwell Kent was presented to the University by Hartely Sherwood, on behalf of the bituminous-coal industry. The painting is one of a series that depict the power and uses of coal. Speaker: L. K. Sillcox, nonresident professorial lecturer in engineering. Subject: Consequences. Attendance: 175.

Jan. 13, Mechanical Engineering Building. Speaker: Prof. H. G. Veneman, professor of refrigeration. Subject: Low-Temperature Refrigeration. Attendance: 75.

Queen's University

Dec. 2. Program: F. W. Cranston, Babcock and Wilcox, Goldie, McCulloch, Ltd., presented films and slides dealing with modern boiler construction.

ASME STUDENT BRANCH OF TUFTS COLLEGE

Rice Institute

Dec. 8, Mechanical Laboratory 206, Donald Dean Weeke, presiding officer. Speaker: Joe Morelege. Subject: Counterbalance for Locomotive Drive Wheels. Attendance: 15.

Jan. 12, Mechanical Laboratory 206. Election of officers was held. Attendance: 31.

Rutger's University

Jan. 12. New officers were elected for the spring term.

University of Southern California

Dec. 11, Annex 101. Speaker: C. T. Colley, member ASME, Link-Belt Company, Los Angeles, Calif. Subject: Belt Conveyers. Attendance: 53.

Jan. 15, Engineering 309. Election of officers for the spring semester was held. Attendance: 42.

Stevens Institute of Technology

Dec. 18, Smoker. Program: An engineer from the Stevens Towing Tank, gave a talk on its accomplishments in the testing and designing of ship hulls. A film was shown depicting towing of models through the water in the three tanks now in use. Speakers: A. R. Mumford, vice-president, ASME Region II, and Prof. John D. Shaw, assistant director, powder-metallurgy laboratory. Thirty members visited the Long Lines Building of the New York Telephone Company on the same date.

University of Texas

Jan. 5. Speaker: Dr. R. W. French, head of the Texas Bureau of Business Research. Subject: Business Outlook for Graduating Engineers.

University of Toronto

Dec. 11. Speaker: Lieut. Col. T. Medland, executive director of the Association of Professional Engineers. Subject: The Engineer in the World of Tomorrow.

Tufts College

Dec. 10, Braker Hall, joint meeting with the other student-engineering societies. Subject: Discussion of pros and cons of the unionization of engineers, sponsored by Tufts Engineering Council. Attendance: 160.

Vanderbilt University

Jan. 12, room 12 Engineering Building, Sam Shelby, presiding officer. Committees were appointed and reorganized as required by the by-laws. Attendance: 37.

Virginia Polytechnic Institute

Jan. 13, W. G. Boggs, presiding officer. Prof. J. B. Jones, member ASME, head of the mechanical-engineering department, presented Stanley Ragone with a junior-membership award, the gift of the Virginia Section ASME. Program: Movie on "Magnesium From the Sea," prepared by the U. S. Bureau of Mines. Attendance: 147.

Jan. 27, Building 365. Program: Technicolor film, "Steam Progress," product of the Combustion Engineering Company, covering the history of steam generators from the Heine boiler down to the present-day high-temperature and pressure boilers. Attendance: 140.

ASME Master-File Information

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Washington State College

Jan. 15, Dean Ladd, presiding officer. Program: Preview of films for possible use in forthcoming programs. Tentative dates were proposed for Northwest Student Conference to be held jointly by the College and the University of Idaho. Attendance: 31.

University of Washington

Jan. 15, Guggenheim Hall. Speaker: Warren Philbrick, member ASME, instructor of mechanical engineering. Subject: Employment Possibilities for Mechanical Engineers in the Pacific Northwest. Attendance: 53.

Wayne University

Jan. 2, field trip to the plant of the Kaiser-Frazer Corporation, Willow Run, Mich.

Jan. 8, Webster Hall, John H. Hughes, presiding officer. Election of officers for the spring semester. Speaker: George Lange, Ex-Cell-O Corporation. Subject: Fuel-Injection Systems for Gasoline Engines. Attendance: 36.

University of West Virginia

Jan. 21, meeting of the branch with T. E. Purcell, vice-president, Region V, ASME, A. J. Kerr, chairman of Student and Recent Grade Committee, Pittsburgh Section, and L. Tattersall, chairman of Membership Development Committee, Pittsburgh Section. Also present were Mr. Davis, dean of the engineering school; Mr. Cather, head of the department of mechanical engineering, Mr. Reynolds, honorary chairman of the student branch, and instructors at the University. Plans were made for expansion of the branch, with the aid of the Pittsburgh Section.

University of Wisconsin

Dec. 9, Mechanical Engineering Building, F. Edward Hillery, presiding officer. Speaker: Dean Withey. Subject: The Professional Status of the Engineer. Attendance: 52.

University of Wyoming

Jan. 20, Engineering Building, Tony Yugovich, presiding officer. This was a joint meeting with the local branches of AIEE and ASCE. Speaker: R. T. McCalmon, Denver representative of A. M. Byers Company. Subject: Radiant Heating. Attendance: 100.

Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

ASME Sections

Coming Meetings

Akron-Canton: March 18. Women's City Club, Akron, Ohio. Dinner at 6:30 p.m.; meeting at 8 p.m. Subject: Smoke Elimination in Our Cities, by Fred D. Mosher, chairman, Advisory Committee on Smoke Abatement, Erie, Pa.

Cleveland: March 11. Cleveland Engineering Society at 8 p.m. Joint meeting with the AIEE Cleveland Section. Subject to be announced. Speaker: T. Keith Glennan, president, Case Institute of Technology, Cleveland, Ohio.

Hartford: March 16. City Club of Hartford, Conn., at 7 p.m. Subject: The Engineer's Place in the World of Tomorrow by A. A. Nichoson, assistant vice-president, The Texas Company, New York, N. Y.

Metropolitan: March 9. Opportunities Forum. Room 501,[1] 7:30 p.m. Subject: Engineer's Opportunities, by E. G. Bailey, president ASME. Free refreshments will be served.

March 11. Special Department, Engineers' Forum. Room 1101,[1] 7:30 p.m. Subject: The World Engineering Conference.

March 11. Woman's Auxiliary Annual Card Party. Engineering Woman's Club, 2 Fifth Avenue, New York, N. Y. Luncheon at 1 p.m. $2.00 per person.

March 16. Materials-Handling Forum. Room 1101.[1]

March 23. Special Department, Engineers' Forum. Room 502,[1] 7:30 p.m. Subject: Taft-Hartley Law as It Affects Engineers, by Bernard Fitzpatrick, director industrial relations, Commerce and Industry Association of N. Y.

March 25. Power Department. Room 502, 7:30 p.m. Subject: Historical Development of the Rocket Motor, by James H. Wyld, chief research engineer, Reaction Motors, Inc.

March 31. Special Department, Photographic Division. Room 1101, 7:30 p.m. Subject: Industry Sits for It's Portrait, by Roy E. Stryker, head of photographic section, public-relations department, Standard Oil Company of N. J.

New Haven: March 10. Place to be announced. Time: 8 p.m. Subject: Report on Jet Propulsion, by Charles L. Fay, director of flight research, Bell Aircraft Corp., Buffalo, N. Y.

Oregon: March 17. Hyster Company plant, 6:30 p.m. Subject: Materials-Handling Equipment Serves Industry, by Eugene Caldwell, general manager, Hyster Company. Talk supplemented by a colored movie, a tour of the plant, and demonstration of products of the Hyster Conpany.

Philadelphia: March 10. Student Night. Subject: Economic Status of the Junior Engineer.

March 16. Room 314, Engineering Bldg., University of Pennsylvania. Subject: The Relation of Pure Science to Engineering, by Dr. W. F. G. Swann, Bartol Research Foundation.

March 17. (Place to be announced). Subject: Engineering Background of Nuclear-Energy Development, by A. L. Baker, vice-president, Kellex Corp., New York, N. Y.

March 23. (To be announced).

March 24. Wilmington Section meeting. (Place to be announced). Joint Meeting with student branch, University of Delaware, Wilmington, Del.

Waterbury: March 16. University Club Rooms, Hotel Elton; dinner at 6:30 p.m.; meeting at 8:30 p.m. Subject: Special-Purpose and Hi-Production Machinery, by Robert G. Dexter, Barkley and Dexter, Boston, Mass.

Worcester: March 4. Worcester Polytechnic Institute; dinner at 7 p.m., meeting at 8 p.m. Subject: Color Conditioning in Industry, by L. E. Whitmoyer, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del.

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[1] Engineering Societies Building, New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

ENGINEER, 32, ME and MS in ChE, registered, 9 years' diversified engineering experience. Desires research or development position with firm whose problems require a background in mechanical and chemical engineering. Me-270.

PLANT ENGINEER, 16 years' experience as master mechanic, plant engineer, and plant superintendent in farm-machinery, automobile, and food-processing plants. Time-study, methods, and building-construction experience. Me-271.

PROCESS-CONTROL ENGINEER, 40, married, ChE, ME in physics, chemistry. Broad background process control, instrumentation, plant design, and operation in chemical and allied industries. Eleven years' instrument-development and process-application engineering, instrument manufacturers. Organizing ability. Desires permanent connection chemical industry. Me-272.

PLANT ENGINEER, BSME, 29, five years' experience in all phases methods engineering, plant supervision, construction, and maintenance. Seeks position with concern that will offer advancement based on merit; presently employed. Me-273.

EXECUTIVE, 43, MIT Graduate BS. Experience in costs, rate setting, and time study; also as industrial salesman, plant superintendent, industrial engineer, production manager, plant manager, and senior consulting engineer. Me-274.

MECHANICAL ENGINEER, BE, 38, married. Presently employed. Wide variety of experience in construction, test procedures, and report writing, steel-mill operation, and mechanical design. Possesses administrative ability and ambition. Desires to engage in progressive enterprise where professional experience and administrative capabilities can be fully utilized. West Coast preferred. Me-275.

MECHANICAL ENGINEER, experience in designing, building, and improving textile machinery, mechanical and electrical research work in supervisory capacity, inventive ability; 26 years with two of the largest carpet mills. Desires responsible position in same field. Me-276.

MECHANICAL ENGINEER, 27, married, 5 years' experience in aircraft and chemical industries, chiefly developmental and experimental work. Some machine design and drafting. Familiar with machine-shop methods. Interested in development or production. Location preferred, Northeast. Me-277.

EXECUTIVE ENGINEER OR PLANT MANAGER, 18 years' experience as an executive in petroleum and process industries as chief engineer in charge of design and construction, also superintendent in charge of manufacturing operations, also superintendent in charge of maintenance and utilities. Has directed activities of over 2000 men. Registered in New York and Illinois. Me-278.

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[1] All men listed hold some form of ASME membership.

POSITIONS AVAILABLE

SUPERINTENDENT OF BUILDINGS AND GROUNDS, 40–50, mechanical graduate, with considerable experience covering maintenance and operation of heating, buildings, power and light, and construction, to take charge of college properties. $5000–$6000. Central New York State. Y-159.

CHIEF ENGINEER, mechanical graduate, with at least 10 years' experience in design and development of computers and electronic controls to supervise design of high-speed computing equipment. $10,000–$12,000. Connecticut. Y-181.

INVESTIGATION ENGINEER, mechanical graduate, to investigate from theoretical background designs for various mechanical projects including designers' calculations on stress analysis, motions, etc. Will analyze field stress analysis motions, etc., also data received from equipment in use. Salary $6500–$7000. Location, upstate New York. Y-207(a).

ELECTRONIC, MECHANICAL ENGINEERS, AND PHYSICIST, BS degree with 3 years' experience in any one of the following fields: servomechanisms, gyroscopics, instrumentation, audio-

(*ASME News continued on page 288*)

frequency, and electromechanics, to do design and development work in the guided-missile field. $4000–$6000. Michigan. Y-219.

MAINTENANCE ENGINEERS, mechanical graduates, or civil engineers with a great deal of mechanical-engineering experience. Must have a minimum of 3 to 5 years' experience in maintenance and construction in an operating refinery or with experience in refinery construction and maintenance work in large construction firms. Living quarters available for men who will go single status. $6300. South America. Y-223.

SALES ENGINEER, mechanical graduate, young, with instrument experience, to sell hydraulic controls and equipment. New Jersey resident preferred. Northern New Jersey. Y-228.

INSTRUCTOR, mechanical graduate, to teach courses in elementary steam engineering, air conditioning, and mechanism; also conduct inspection trips. $2400 a year plus cost-of-living allowance of $480. Start September, 1948. Ohio. Y-243.

MECHANICAL-DESIGN DRAFTSMAN, with at least 5 years' process and power-piping experience to lay out and detail sugar-mill piping and equipment. $6000–$7000. New York with occasional traveling to Caribbean area. Y-255.

MECHANICAL ENGINEER to prepare layout drawings and follow through on installation for research laboratory. Must have experience in high-pressure steam, stills, and autoclaves. Salary open. New York, N. Y. Y-259.

JUNIOR MECHANICAL ENGINEER, with 1 to 3 years' experience, preferably with thermostatic metals. Will do general engineering work, including research, development, and some production. Experience in heat-control or instrument field desirable. $3600–$3900. Northern New Jersey. Y-267.

INSTRUCTOR, young, mechanical degree, for machine-tool laboratory. Should have some experience in actual machine-shop operation, and also understand something about tooling. Will be given responsibility of machine-tool laboratory. Position starts end of March. Salary open. Washington State. Y-272.

MECHANICAL ENGINEER, young, with heating-equipment experience to service controls, automatic traps, vacuum pumps, and regulators; do office routine and later become sales representative. $2200–$3120. New York, N. Y. Y-275.

MACHINE-TOOL DESIGNERS, 35–40, with mechanical-engineering degree and minimum of 5 to 10 years' experience, in the design of heavy machinery. Position will eventually lead to chief draftsman. Company will pay expenses. $5000–$6000. Southern Ohio. Y-283.

MECHANICAL OR ELECTRICAL ENGINEER, 30–35, with thorough technical education, to prepare plans and specifications for installations in industrial and commercial buildings of heating and ventilating, plumbing, and other piping trades, electric-light and power wiring, and air conditioning; prepare estimates of cost of such installations; supervise such work being performed by subcontractors. Should have a general acquaintance with all subjects mentioned above and expert knowledge of one or more. Should have administrative ability to employ and direct assistants or specialists. Up to $6000 a year, plus bonus. Ohio. Y-291.

MECHANICAL DESIGNER with experience on heavy journal bearings, particularly as applied to locomotives and railroad cars. Part time. Salary open. Northern New Jersey. Y-311.

MECHANICAL ENGINEER, with 1 or 2 years' experience in general plant maintenance or a recent graduate with real aptitude. Work consists of making drawings, calculations, and designs for pipe layouts, structural work, special machinery, tanks, mixers, etc. Man raised in the South preferred. $3600–$4200. Virginia. Y-315.

DESIGNER, mechanical graduate with large steam-turbine-design experience to design and work with group on design of power-plant unit. $6000–$7500. Pennsylvania. Y-316.

CHIEF ESTIMATOR, 35–45, mechanical graduate, with 10 or more years' experience in a stamping plant, with 5 years of this experience in handling major responsibilities. Will be responsible for all estimating done by division. Will estimate automobile-, refrigeration-, electrical-, and farm-equipment parts and assemblies, including cost of tooling. Will follow through with sales to see that estimates are in line. Will have supervision several engineers. $6000. Ohio. Y-321.

PLANT ENGINEER, 35–40, mechanical graduate, with professional-engineering license in New Jersey desirable. Should have experience in paperboard manufacturing; experience in building, design, and construction, desirable. Will be in charge of equipment-engineering department, to do repair jobs, layouts, and investigation of new equipment, $7000–$8000. Northern New Jersey. Y-352.

MECHANICAL ENGINEER with 5 to 10 years' experience in chemical-plant processing equipment for development of new products with an established firm. Will be required to do a technical as well as a sales job in developing the products and in his contacts with the chemical industry. Western Pennsylvania. Y-360.

EXPORT ENGINEER, 35–40, mechanical graduate, with at least 5 years' experience covering steel bars, shapes, sheets, machinery, and equipment to analyze inquiries, prepare quotations, and follow up purchasing, shipment, and payments. $5000–$6000. New York, N. Y. Y-365.

PLANT ENGINEER, 30–35, mechanical graduate, with at least 3 years' experience, preferably in paper mill, to design and lay out installation of papermaking and power-plant equipment. $4000–$5000. Upstate New York. Y-370.

MECHANICAL ENGINEER to teach aerodynamics, aeronautical power-plant design, and construction. In addition will be called on to teach other subjects in the mechanical-engineering department. $4000 for 9½ months' work. Position carries the rank of assistant professor, Pacific Northwest. R-4718-C.

MECHANICAL ENGINEER, graduate, to design coal-mining machinery, particularly coal loaders and undercutters. Will be in direct charge of design and development work. $6240 and up. East central Wisconsin. R-4739-C.

MECHANICAL DESIGNER, 35–45, graduate, with several years' experience in the design of intricate automatic machines, preferably in food, tobacco, paper, or clothing industries. Do *not* want automotive or machine-tool experience, but versatile designer on special intricate packaging and mechanical-handling equipment. Must be capable of handling a crew of designers and preferably possess a few patents. Salary open. Location Michigan. D-3687.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after March 25, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ABOU-SABE, ADEL HAMID, Berkeley, Calif.
AMRINE, HAROLD T., Lafayette, Ind.
ANDERSON, CHARLES J., Syracuse, N. Y.
ANTON, NICHOLAS G., Brooklyn, N. Y.
ARONOW, MARTIN, L., Camden, N. J.
ATALLA, M. M., W. Lafayette, Ind.
BABOCK, HENRY A., Los Angeles, Calif.
BANERJEE, R. N., Minneapolis, Minn.
BARKHAM, J. E., Oxnard, Calif.
BAUTISTA, MARCIAL M., Malate, Manila, P. I.
BEASLEY, RICHARD ARTHUR, Washington, D. C.
BEAUDRY, HARRY J., Manitowoc, Wis.
BLACK, THOMAS A., Edgewood, Pittsburgh, Pa.
BOGARDUS, FRANKLIN F., Connersville, Ind.
BORAH, KENNETH, Wood River, Ill.
BOURCY, JOSEPH E., Rochester, N. Y.
BOWERSETT, C. F., Laurel, Md.
BRANDT, WELDON H., Pittsburgh, Pa.
BRESNAHAN, JAMES K., Lomita Park, Calif.
BROMBACHER, W. G., Chevy Chase, Md.
BULMER, CHARLTON ALEXANDER, Buffalo, N. Y.
CAMPBELL, W. R., Winnipeg, Manitoba, Can.
CAMPBELL, JOHN, JR., Carrecroft, Wilmington, Del.
CARTER, WILLIS MERLE, Lexington, Ky.
CERVARICH, FRANK RAYMOND, Richmond, Va.
CIPRIANO, JOSEPH A., East Boston, Mass.
CLARK, RICHARD B., Sidney, N. Y.

(*ASME News continued on page 290*)

COFFIN, C. W. FLOYD, Englewood, N. J.
CONE, ELWOOD E., San Francisco, Calif.
COOK, GEORGE, 2ND, Wilmington, Del.
COOLEY, GORDON A., SR., Chicago, Ill.
COTTON, JOHN S., Fort Bragg, Calif.
CRABTREE, WILLIAM R., New Bedford, Mass. (Rt & T)
CROWLEY, AMBROSE F., Garden City, N. Y.
CROWLEY, THOMAS T., Coraopolis, Pa.
DESAULNIERS, ANTOINE T., Macon, Ga.
DHANARAJ, SAMUEL, Bangalore, South India
DONALDSON, R. M., Hampton, Va.
EISENSTADT, RAYMOND, Brooklyn, N. Y.
ENGLISH, EDWARD JOSEPH, Jersey City, N. J.
FARLEY, NELSON E., Willow Run, Mich.
FRANTZ, CHARLES E., Richland, Wash.
FRAZIER, C. H., Lakewood, Ohio
FRY, HAROLD, Laramie, Wyo.
FULKERSON, ARCHIE P., Louisville, Ky.
FULLER, FORNEY, JR., Charlotte, N. C.
GASS, KARL W., Pittsburgh, Pa.
GIBSON, CHRISTIAN D., Greene, N. Y.
GIFFORD, ALLEN G., Harborcreek, Pa.
GLOVER, CLIFTON, Portland, Oregon
GORDON, CLIFFORD K., Lakewood, Ohio
GRANT, JAMES A., Toronto, Ont., Can.
GRUITCH, JERRY M., New York, N. Y.
HAFNER, OTTO PAUL, Merchantville, N. J.
HALL, JOHN, New York, N. Y.
HARDER, WILLIAM F., Lincoln, Neb.
HERBERT, WILBUR F., Montclair, N. J.
HIGH, JOHN J., Westfield, N. J.
HILEY, T. J., Savannah, Ga.
HOCH, HAROLD S., Baltimore, Md.
HORNIG, W. W., Greensboro, N. C.
HORRES, LEO, Dayton, Ohio
HORSTMAN, E. H., Wauwatosa, Wis. (Rt & T)
HUNT, MALCOLM M., Worcester, Mass.
IRWIN, ROSS, Rochester, Ill.
JAGGER, HUBERT, Redwood City, Calif. (Rt & T)
JARMY, HOWARD, Chicago, Ill.
JENKINS, DONALD R., Easton, Pa.
JONES, ARTHUR L., JR., Birmingham, Mich.
KAPLAN, BERNARD, New York, N. Y.
KELLS, CHARLES F., Douglaston, N. Y.
KING, HAROLD S., Goshen, Ind.
KING, JOSEPH A., Union, N. J.
KIKER, JOSEPH C., Houston, Texas
KIRCHER, RALPH N., West Bend, Wis.
KIRK, WILLIAM B., Taft, Calif.
KISSICK, JOSEPH, JR., White Plains, N. Y. (Rt)
KNOWLES, THEODORE K., Fairlawn, N. J. (Rt & T)
KOTH, ARTHUR, Grand Forks, N. D.
LANGE, H. FREDERICK, Peoria, Ill.
LAW, WILLIAM J., JR., Baltimore, Md.
LAYMAN, DOUGLAS C., Jeannette, Pa.
LEE, RODERIC B., N. St. Petersburg, Fla.
LITTLE, EDWARD M., Silver Spring, Md.
LONG, JOHN JOSEPH, Guilford, Conn.
LORANT, HUGO, New York, N. Y.
LOVELL, WILLIAM S., Savannah, Ga.
LUCAS, WILFORD E. G., St. Albans, N. Y.
LUGINBILL, CHARLES F., Cuyahoga Falls, Ohio
LYETH, ARTHUR G., JR., Wellesley Hills, Mass. (Rt & T)
MACLEOD, DAVID E., Los Angeles, Calif.
MANNING, ROBERT P., Alhambra, Calif.
MARSHALL, THOMAS A., JR., New York, N. Y.
MASCARENHAS, B. P., Boston, Mass.
MATA, M. S., San Juan, Rizal, Philippines
MAY, ELWOOD RUSSELL, Wilkes-Barre, Pa.
MCLARNEY, WM. J., Berwyn, Md. (Rt & T)
MEAD, W. BURR, Baltimore, Md.
MILLER, RAYMOND H. P., Madison, Wis.
MOORE, WILLIAM THOMAS, Oak Ridge, Tenn. (Rt & T)
MURDOCK, THOMAS B., Schenectady, N. Y.
MYLANDER, HARVEY A., Los Angeles, Calif.
NIAYESH, HESHMATOLLAH, Teheran, Iran
NIELAND, PAUL J., St. Paul, Minn.
OBERBY, EUGENE H., Savannah, Ga.
OLSEN, ROGER C., Chicago, Ill.
OSBORN, KENNETH R., Haddonfield, N. J.
OSTADAHL, HAROLD E., Wilmington, Del.
PARK, HERBERT M., Youngstown, Ohio
PARRETT, JOHN T., New York, N. Y.
PAVOLKO, GEORGE JAMES, Lorain, Ohio
PEARCE, D. M., JR., Glen Rock, N. J.
PHANEUF, RODOLPHE E., Montreal, Quebec, Can.
PHELPS, KENNETH G., South Lyon, Mich. (Rt)
POLLARD, R. SPOTSWOOD, Philadelphia, Pa. (Rt & T)
RANNEY, W. E., Louisville, Ky.
REICHARD, J. B., Akron, Ohio
REYNOLDS, CLIFFORD JACK, Toledo, Ohio
RHODEN, H. G., Cambridge, England
RIETMANN, E. A., New York, N. Y.
ROBERTSON, GORDON, Springfield, Mass.
ROBINSON, JAMES E., Columbus, Ohio
ROCHE, DAVID M., Lorain, Ohio
ROGERS, HARRY S., New York, N. Y.
ROTHCHILD, OSCAR A., Chicago, Ill.
SALDAT, JOHN H., Niagara Falls, Ont., Can.
SAWYER, JOHN W., Washington, D. C. (Rt & T)
SCHALLER, EDGAR C., Des Moines, Iowa
SCHIFFLIN, ARTHUR K., Indianapolis, Ind.
SCHUBERT, DALE L., Tacoma, Wash. (Rt & T)
SCOTT, HARRY R., JR., Baltimore, Md.
SCOTT, JAMES C., Long Branch, Ont., Can.
SIMMS, E. RALPH, JR., New York, N. Y.
SKINNER, A. C., JR., Jacksonville, Fla.
SMITH, JOHN EDGAR, SR., Springfield, Pa.
SOISSA, J. A., Kenilworth, Ill.
STALKER, EDWARD A., Bay City, Mich. (Rt)
STRIMEL, GEORGE H., Irvington, N. Y.
SZENAS, ALEXANDER A., Greensburg, Pa.
VANDER BOEGH, BRUCE LEE, Hampton, Va.
WAGNER, C. EHRLER, Snyder, N. Y.
WARNER, W. W., Kent, Ohio
WAY, ROBERT C., Columbus, Ohio
WEISSER, N. M., Brooklyn, N. Y.
WHEELER, W. A., JR., Bridgeport, Conn.
WHITE, ROBERT C., Ann Arbor, Mich.
WILLARD, W. R., San Mateo, Calif.
WILLIAMS, EDWIN S., Chattanooga, Tenn.
WILLIAMS, F. D. M., Nobel, Ont., Can.
WINKELMAN, FREDERIC WILLIAM, Lavallette, N. J.
WINSKI, SIDNEY Z., San Angelo, Texas
WOOD, PAUL I., Burbank, Calif.
WYMBS, NORMAN E., Evanston, Ill.
YEARDLEY, JAMES H., Uniontown, Pa.
ZOBSCH, ARNOLD BERNARD, Faribault, Minn.

CHANGE IN GRADING

Transfers to Fellow

BELL, FRANK S., Pittsburgh, Pa.
BIGGERT, F. C., JR., Pittsburgh, Pa.
FOX, JOHN H., Pittsburgh, Pa.
GALLALEE, JOHN MORIN, University, Ala.
JOLLY, THOMAS D., Pittsburgh, Pa.
TRINKS, WILLIBALD, Pittsburgh, Pa.

Transfers to Member

AUSTIN, HOYT, Barcelona, Venzuela
BASSETT, WILLIAM V., Bethlehem, Pa.
BLISS, JOHN WARREN, Bethlehem, Pa.
BRESLOVE, JOSEPH, Pittsburgh, Pa.
CHIAVETTA, VIRGIL V., Somerville, N. J.
DAWSON, JOHN T., Emeryville, Calif.
FIXMAN, C. M., Redwood City, Calif.
FRYER, ROSS LAUPER, Cleveland, Ohio
GILES, CHARLIE M., Seattle, Wash.
GRUMBLATT, VICTOR J., Erie, Pa.
HALL, COLLIER, Louisville, Ky.
HOCKEMA, FRANK C., Lafayette, Ind.
JEFFERDS, JOSEPH C., Charleston, W. Va.
KRAMER, BERNARD L., Albany, N. Y.
MEHRINGER, FRANK J., Cambridge, Mass.
POWELL, S. CURTIS, Quincy, Mass.
PURDY, ALBERT A., Wollaston, Mass.
RENDOS, JOHN J., Stamford, Conn.
SCHMOYER, RICHARD L., Fullerton, Pa.
SUDDUTH, H. NORTON, Watertown, N. Y.

Transfers from Student Member to Junior...... 70

Necrology

THE deaths of the following members have recently been reported to headquarters:

BATEMAN, GEORGE F., January 29, 1948
DEXTER, HOWARD W., JR., January 18, 1948
GEORGER, FRANCIS A., JR., June, 1947
GREEN, HEATLEY, September 20, 1947
HALL, RODNEY D., January 13, 1948
HAMILTON, WILLIAM J., January 27, 1948
HUNT, ROBERT, November 26, 1947
HUNTER, JOHN ALEXANDER, November 17, 1947
KLEIN, AUGUST C., February 2, 1948
LE PAGE, CLIFFORD B., January 15, 1948
MACK, ALBERT J., October 25, 1947
OLDHAM, PERCY T., January 18, 1948
SANGSTER, WILLIAM, December 15, 1947
SCHWARTZ, ANDREW J., October 12, 1947
SHERMAN, WARREN S., December 19, 1947
TERRY, ROGER V., January 9, 1948
TODD, PAUL E., November 28, 1947
WOKURKA, ELMER O., May 12, 1947
WRIGHT, ORVILLE, January 30, 1948

ASME Transactions for February, 1948

THE February, 1948, issue of Transactions of the ASME contains the following:

Meter for Flowing Mixtures of Air and Pulverized Coal, by H. M. Carlson, P. M. Frazier, and R. B. Engdahl
Test Data on Gas-Side Sulphate-Type Deposits on Tubes Beyond Boiler Furnace, by J. F. Barkley, L. R. Burdick, and A. A. Berk
Progress Report No. 1 on Tool-Chip Interface Temperatures, by K. J. Trigger
The Role of Meehanite Metal Castings in Engineering Production, by C. R. Austin
Nozzle Flow Characteristics in Pneumatic Force-Balance Circuits, by D. B. Kirk
Some Properties and Mechanical Applications of Compar, by J. J. Hitov
Cross-Laminated Oak, by E. G. Stern
Stretch Notch Sensitivity With Eccentric Holes, by L. Schapiro and R. H. Esling
Discussion, by J. K. Salisbury